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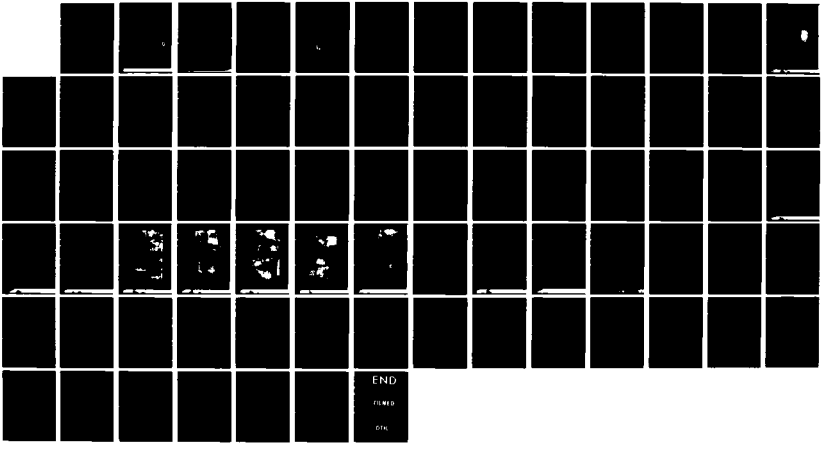
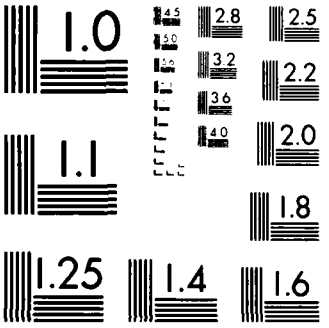




MERRIMACK RIVER BASIN

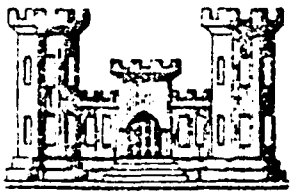
NORTH ANDOVER, MASSACHUSETTS

LAKE COCHICHEWICK OUTLET DAM

MA 00278

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DECEMBER 1978

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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7 AUTHOR(s) U.S. ARMY CORPS OF ENGINEERS NEW ENGLAND DIVISION		8 CONTRACT OR GRANT NUMBER(s)
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Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19 KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Merrimack River Basin
North Andover, Massachusetts
Conduit to Stevens Pond

20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is about 12 ft. in height and includes a cutstone gate structure and underground conduit to convey water downstream. The dam is generally in good to fair condition. The size is intermediate and the hazard potential is high. A professional engineer should be hired to detemine the size shape and condition of the outlet conduit in order to evaluate the hydraulic and structural adequacy of the structure.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:

NEDED

FEB 23 1979

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

Dear Governor King:

I am forwarding to you a copy of the Lake Cochichewick Outlet Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, the Town of North Andover, Department of Public Works, 384 Osgood Street, North Andover, Massachusetts 01845, ATTN: Mr. Joseph J. Borgesi, Superintendent.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely yours,

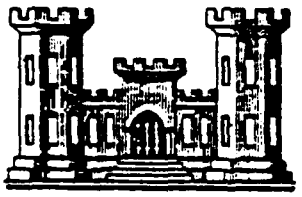
JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

MERRIMACK RIVER BASIN
NORTH ANDOVER, MASSACHUSETTS

LAKE COCHICHEWICK OUTLET DAM
MA 00278

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

DECEMBER 1978

MERRIMACK RIVER BASIN

NORTH ANDOVER, MASSACHUSETTS

LAKE COCHICHEWICK OUTLET DAM

MA 00278

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS 02154

DECEMBER 1978

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM

Identification No.:	MA 00278
Name of Dam:	Lake Cochichewick Outlet
Town:	North Andover
County:	Essex
State:	Massachusetts
Stream:	Conduit to Stevens Pond
Date of Site Visit:	3 October 1978

BRIEF ASSESSMENT

This dam at the outlet of Lake Cochichewick retains a reservoir used for water supply by the Town of North Andover. The dam is approximately 12 ft. in height and includes a cut-stone gate structure and underground conduit to convey water downstream. The dam is believed to have been built around 1837. There is no discernible embankment or spillway at the site, perhaps being obscured by subsequent filling operations including the construction of a railroad embankment.

Due to the extent of downstream development that would be affected in the event the dam were to fail, Lake Cochichewick Outlet Dam is classified as having a "high" hazard potential in the Corps of Engineers National Inventory of Dams.

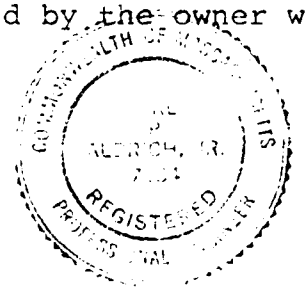
Based on a visual examination of the structure, the facility generally is in good to fair condition. The condition of the outlet conduit could not be assessed. However, there was no evidence of structural failure or other conditions which would warrent urgent remedial action.

Based on size (intermediate) and hazard (high) classifications in accordance with the Corps of Engineers guidelines, the test flood for this dam is the Probable Maximum Flood (PMF). The PMF outflow of 685 cfs (120 csm) would overtop the stone platform called top of dam by about 0.5 ft. (after adjacent eroded ground surface areas are raised as much as 1.2 ft. to the level of the platform). With the water level at top of dam the gate structure can pass 200 cfs which is 29 percent of the test flood outflow.

The Town of North Andover, owner of the dam, should engage a registered professional engineer to determine the size, shape and condition of the outlet conduit in order to evaluate the hydraulic and structural adequacy of the structure. This investigation and remedial measures, including the filling and restoration of eroded ground surface areas, realigning the stones in the approach channel walls, filling open joints with mortar and refinishing the gate structure doors, as outlined in Section 7.3, should be implemented by the owner within two years after receipt of this report.

HALEY & ALDRICH, INC.
by:

Harl Aldrich
President



This Phase I Inspection Report on Lake Cochichewick Outlet Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Richard F. Doherty

RICHARD F. DOHERTY, MEMBER
Water Control Branch
Engineering Division

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Joseph A. McElroy

JOSEPH A. MCELROY, CHAIRMAN
Chief, NED Materials Testing Lab.
Foundations & Materials Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, DC 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I Investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the test flood is based on the estimated "probable maximum flood" for the region (greatest reasonably possible storm run-off), or a fraction thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment

of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

1. Overview of Lake Cochichewick Outlet dam

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

A. Condition. The visual examination of Lake Cochichewick Outlet Dam revealed that the structure was in good to fair condition, although the condition of the outlet conduit could not be assessed. Nevertheless, there were no signs of structural failure or other conditions which would warrant urgent remedial action. Several deficiencies were noted which require attention.

Based on the results of computations included in Appendix D and described in Section 5, the outlet is not capable of passing the test flood, which for this structure is the PMF, without overtopping the dam. The capacity of the outlet conduit is estimated to be 200 cfs while the PMF is 685 cfs.

B. Adequacy of Information. In general, available information was adequate for the Phase I investigation. However, there is no information available on the outlet conduit. Since the conduit is the only outlet (or spillway) from Lake Cochichewick, its structural condition should be determined.

C. Urgency. The recommendations for additional investigations and remedial measures outlined in Section 7.2 and 7.3, respectively, should be undertaken by the Owner and completed within two years after receipt of this report.

D. Need for Additional Investigation. An additional investigation should be performed by the Owner as outlined in Section 7.2.

7.2 RECOMMENDATIONS

It is recommended that the Owner engage a registered professional engineer to perform an investigation on the outlet conduit. The investigation should include the determination of the size, shape and condition of the outlet conduit. It should contain an evaluation of the hydraulic and structural adequacy of the conduit.

7.3 REMEDIAL MEASURES

Although the dam is generally maintained in good condition, it is considered important that the following items be

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observations. There is no discernible embankment or spillway present at the dam site. However, the cut-stone masonry arch through the railroad embankment would act as the "emergency" spillway outlet in the event the dam were overtopped.

The condition of the outlet conduit is unknown, as the conduit was filled with water. It has been reported to be a stone masonry structure. The top of the outlet headwall and the vintage of the construction appear to confirm this.

B. Design and Construction Data. There are no plans of the outlet conduit available or believed to exist.

C. Operating Records. There are no operating records available, other than periodically measured reservoir water level elevations.

D. Post-Construction Changes. As discussed in Sections 1.2B and 1.2H, the railroad embankment and underpass are believed to have been constructed after the dam and may have masked its original configuration. No post-construction changes are apparent at the outlet structure.

E. Seismic Stability. The dam is located in a Seismic Zone 3. Because of its configuration, condition and the low head of water retained, a seismic analysis of the "embankment" is not considered necessary.

There are no plans available on the outlet conduit and the structure could not be observed. It is therefore impossible to comment on the structural stability of the conduit except that being a stone masonry structure in a Zone 3 seismic risk area, it may not be stable for normal seismic loadings appropriate to the area.

proximity of the Mill Pond Condominiums to the dam, the test flood has been designated the PMF.

A rating curve for the dam's gate structure was developed, and demonstrated that the maximum flow that the head gate can pass is an estimated 200 cfs. Therefore, since the maximum outflow is 685 cfs, it is apparent that the gate structure can pass only 29% of the test flood. At the maximum outflow, the pond level is 115.31 ft. (MSL).

Overtopping would thus involve an approximately 6-in. deep sheet flow of water over the top of the dam (after earth fill grades are raised to the level of the stone platform) and down the grassed ground surface toward the underpass tunnel. Flow would be conveyed through the tunnel to Stevens Pond. If the flow were sustained, the underpass foundations could be undermined and the archway would collapse.

E. Evaluation. As stated previously, the gate structure is incapable of handling the PMF. A failure of this dam would result in excessive damage (and therefore high economic losses) to residential structures as well as probable loss of life.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

A. Design Data. No plans nor any hydraulic/hydrologic design data were available for Lake Cochichewick. The recommended test flood for the size (intermediate) and hazard potential (high) of this dam is the probable maximum flood (PMF).

B. Experience Data. The "SCS TP-149 Method For Estimating Volume and Rate of Runoff In Small Watersheds" was used as a guide for determining the inflow hydrographs into Lake Cochichewick for the PMF. The PMF was routed through the head gate using the method for flood routing presented in "Water Supply and Wastewater Disposal" by Fair and Geyer. The PMF was based on a 23-inch rainfall in 6 hours and was found to have a peak inflow rate of 20,200 cfs, which when routed through the lake was reduced to a maximum outflow of 685 cfs at a water surface elevation of 115.31 ft. (above MSL). The highest water surface elevation reported to have occurred is 113.6 feet (MSL) on 1 April 1951.

C. Visual Observations. The inspection revealed that a section of the dam had eroded to approximately elevation 113.6 ft. from the top of dam elevation of 114.8 ft. Any released water is conveyed via a closed conduit (of undetermined size) into Stevens Pond. Stevens Pond is divided by the access road and the water is conveyed by an approximate 6-ft. by 6-ft. culvert. At the downstream end of Stevens Pond, the water flows through a 30-in. dia. corrugated aluminum pipe under Stevens Pond into a small body of water ("Mill Pond") surrounded by the Mill Pond Condominiums. There also exists another culvert (rectangular in shape and of unknown size) which passes under Stevens Road. This culvert appears to be the original channel which carried water under the now torn down Stevens Mill. However, it is full of debris and appears incapable of passing flow. At the downstream end of this pond, a weir/stilling basin arrangement exists and appears to control the level in this mill pond. The weir is 5 ft. in length, 8 feet in height with an upstream sloping (1:2) face, and wooden flashboards. The chute opening is approximately 2 ft. in width and 3 ft. in height. The waters are conveyed from this point in a series of closed culverts and open channels of various sizes until the brook reaches Phillips Road. At this point, the brook is in an open natural channel (except for culverts under roads) until it reaches the Merrimack River.

D. Overtopping Potential. As stated previously, based on the size (intermediate) and hazard (high) classifications published in the Guidelines, the test flood is the PMF. Also, because of the

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

In general, there are no established operational procedures, maintenance programs or formal warning systems in effect for this dam.

4.2 MAINTENANCE OF DAM

There are no established procedures or manuals to assure periodic inspection and maintenance of the dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

The gate structure, timber gate and gate control do not receive maintenance on a routine basis.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system or emergency preparedness plan in effect for this structure.

4.5 EVALUATION

A periodic observation and maintenance program should be established to examine the dam, control its deterioration and insure operability of its gate. The maintenance has been on a demand basis. A formal procedure should be established for the inspection of the gate at yearly intervals and the inspection of the approach channel and outlet conduit every two years.

The masonry in the gate structure is in good condition with only a few of the joints missing mortar. The steel doors have started to rust and there are a few bullet holes present, as shown in Photo No. 8. Minor effloresecence is present on the interior of the substructure. While the gate could not be closely examined, it is operational and no problems were observed while looking at the top of the gate. Operation of the gate and a closeup of the control are shown in Photos No. 8 and 9, respectively.

The approach channel right wall, Photo No. 6, contains no mortar in the joints and the end of the wall has some displaced stones. The fill behind the wall has eroded exposing the back of the top stones. The approach channel left wall, Photo No. 7, also has no mortar in the joints and there is general displacement of the stones above the water level. The top portion of this wall is above the adjacent embankment, Photos No. 3, 4 and 5.

The outlet conduit is reported to be an underground stone channel or conduit to the pond below the lake. The owner reported that it had been inspected several years ago but no records of the inspection were available. Only the top of the headwall at the outlet is visible and is shown in Photo No. 10. Judging from the displaced stones and the raviling of the embankment in the area it is estimated that a partial blockage of the outlet is present.

The underpass below the railroad embankment which would serve as an emergency spillway to convey flows into Stevens Pond is shown in Photo No. 11. This arch tunnel is constructed of quarry-cut stone and contains no mortar in the joints. The embankment through which it passes is severely eroded. The slopes are steeper than 2 horizontal to 1 vertical and are heavily wooded.

D. Reservoir Area. The area around Lake Cochichewick is generally very steep to rolling, wooded terrain. There appears to be little probability that landslides into the reservoir would cause waves which would overtop the dam. No conditions which might result in a sudden increase in sediment load into the lake were noted.

3.2 EVALUATION

The general condition of the outlet structure is good. The approach channel walls appear to be in fair structural condition. However, the condition of the outlet conduit is unknown. Based on the visual examination, there appears to be no significant potential for failure of the dam at this time.

SECTION 3 - VISUAL EXAMINATION

3.1 FINDINGS

A. General. The Phase I visual examination of the Lake Cochichewick Outlet Dam was conducted on 3 October 1978.

In general, the project was found to be in good to fair condition, although the condition of the outlet conduit could not be assessed. A few deficiciencies which require correction were noted.

A visual inspection check list is included in Appendix A and selected photographs of the project are given in Appendix C. A "Site Plan Sketch", Appendix C-1, shows the layout of the project and the location from which each photograph was taken.

B. Dam. There is no discernible dam embankment or spillway structure at the site. As can be seen on the "Site Plan Sketch", Appendix C-1, the area downstream of the gate structure is relatively level, bordered by a hillside on the right and the railroad embankment on the left. As discussed in Section 1.2B, there was probably a low earth dam at the site which was subsequently masked by the construction of the railroad embankment and other filling operations.

The ground surface slopes gently (approximately 3 percent) from the gate structure to the underpass tunnel. This area is clear of vegetation and generally grass-covered, as shown on Photo No. 3. As shown on this photo, ground adjacent to the stone platform at the gate house has eroded, particularly on the left side. These eroded areas would allow overtopping of the dam at a reservoir level of El. 113.6, which is 1.2 ft. lower than the stone platform called the top of the dam.

Erosion by foot traffic has taken place adjacent to the left approach channel wall, Photo No. 4, and to a lesser extent along side the right approach channel wall. There is no riprap protection along the shoreline, Photo No. 1. The areas left and right of the dam are covered by brush and woods.

C. Appurtentant Structures. The outlet structure for the lake is a stone masonry structure, shown in Photo No. 2, containing a single timber gate. Two small walls of stone masonry form the sides of the approach channel. An underground stone masonry water-conveying structure serves as the outlet conduit to a pond below the lake.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN RECORDS

There are no design records available for this dam, which is believed to have been constructed in 1837.

2.2 CONSTRUCTION RECORDS

No construction records are available for this dam.

2.3 OPERATIONAL RECORDS

The water level of Lake Cochichewick is periodically measured and recorded by the Town of North Andover, Department of Public Works. Inspection reports by county and state agencies that document the reported condition of the dam since 1916 are available.

2.4 EVALUATION

A. Availability. A list of all engineering data available for use in preparing this report is included in Appendix B-1. Selected documents from the listing are also included in Appendix B.

B. Adequacy. Insufficient engineering data were available on the outlet conduit to properly evaluate its hydraulic characteristics and seismic stability. Therefore, the evaluation made in this report depended solely on the visual observations described in Section 3 and hydraulic assumptions discussed in Section 5.

C. Validity. There is no reason to doubt the validity of the available engineering data.

D. Reservoir

1. Length of maximum pool..... 2.3 mi. (Est.)
2. Length of normal pool..... 2.3 mi. (Est.)
3. Length of flood control pool..... Not applicable

E. Storage (acre-feet)

1. Top of dam..... 2380
2. Test flood pool..... 2680
3. Flood control pool..... Not applicable
4. Normal pool..... 1307
5. Spillway crest..... Not applicable

F. Reservoir Surface (acres)

1. Top of dam..... 605
2. Test flood pool..... 605.2
3. Flood control pool..... Not applicable
4. Normal pool..... 560
5. Spillway crest..... Not applicable

G. Dam Embankment. There is no obvious embankment forming the dam as discussed in Section 1.2B and Section 3.1B.

H. Diversion and Regulating Facilities. Not applicable.

I. Spillway. Not applicable. If water were to overtop earth fill adjacent to the gate structure, it would flow through the underpass below the railroad embankment.

J. Regulating Outlets. The regulating outlet for this dam is a hand-operated timber gate. The gate operator consists of a rack and pinion gear in which a pry bar is inserted and the gate lifted by lever action. A ratchet device prevents the gate from falling when inbetween lifts. The gate is approximately 5 ft. wide and 4 ft. high. Its invert elevation is estimated to be 103. The conduit from this gate is an underground stone structure which discharges below the water surface in the pond below the lake. The size and shape of this water conveying structure is unknown.

A. Drainage Area. The drainage area of Lake Cochichewick is approximately 5.7 square miles (3,648 acres). The lake's surface comprises approximately 15 percent of the total drainage area. Lake Cochichewick's watershed is a mixture of very steep to rolling terrain with sections of marshlands to the north and south of the pond. Several small unnamed streams as well as the tributary surface runoff feed the lake. The lake is the main source of water supply for the Town of North Andover.

B. Discharge at Dam Site

1. Outlet Works	4-ft. by 5-ft. head gate with invert about El. 103
2. Maximum known flood at dam site	Unknown
3. Ungated spillway capacity at test flood pool	Not applicable
4. Ungated spillway capacity at test flood pool elevation	Not applicable
5. Gated spillway capacity at normal pool elevation	Not applicable
6. Gated spillway capacity at test flood pool elevation	Not applicable
7. Total head gate capacity at test flood pool elevation	200 cfs at El. 115.3
8. Total project discharge at test flood pool elevation	685 cfs at El. 115.3

C. Elevation (ft. above MSL)

1. Top dam (stone platform at gate structure)	114.8
2. Test flood pool-design surcharge	115.3
3. Design surcharge - original design	Unknown
4. Full flood control pool	Not applicable
5. Normal pool	110.0
6. Spillway crest (gated)	Not applicable
7. Upstream portal invert diversion tunnel	Not applicable
8. Streambed at centerline of dam	103 (Est.)
9. Maximum tailwater	Unknown

ft. downstream would be inundated, as well as the access road to the dam's gatehouse, Stevens Street, Phillips Road, Harraway Road, and even thoroughfares further downstream if the sluice gates on the river (between Route 125 and the confluence with the Merrimack River) were in the closed position at the time of failure. It is evident that this flooding would cause excessive damage to the structures, and, therefore, high economic losses. Loss of life would very likely be unavoidable.

E. Ownership. The name and address of the current owner are:

Town of North Andover
Department of Public Works
384 Osgood Street
North Andover, MA 01845

Mr. Joseph J. Borgesi is presently the Superintendent of the Department of Public Works.

The current owner purchased the dam and water rights from Landers Electric Company, North Andover, MA in March 1973. Prior to April 1972, the owner of the dam was the J.P. Stevens Company.

F. Operator. Mr. Archie Beaudin, Supervisor of Pumping Stations, is responsible for the operation of the dam.

G. Purpose. The dam was built to increase the storage capacity of Lake Cochichewick, which is a water supply for the Town of North Andover. Originally, water released through the dam to Stevens Pond was used by the mills. The level of Stevens Pond is now regulated primarily for recreational purposes by water released through the dam.

H. Design and Construction History. The current and prior owners listed in this report have no records of the design and construction history of this dam. The dam is believed to have been constructed in 1837 and subsequently altered by the construction of the railroad embankment as discussed in Section 1.2B.

I. Normal Operational Procedures. There is no formal established routine for the operation of this dam. Maintenance is performed on the basis of need. Owners of downstream dams, sluiceways and control structures are notified prior to the release of water at this outlet.

1.3 PERTINENT DATA

A reservoir level gauge has been etched into the granite on the right wall of the gate structure, as shown in Photograph No. 6. The datum for this gauge is believed to be mean sea level (MSL), and all elevations used herein were measured relative to this gauge.

1.2 PROJECT DESCRIPTION

A. Location. The dam is located at the westerly point of the southern tip of Lake Cochichewick in North Andover, Massachusetts as shown on the Location Map, page viii. Discharge from the dam flows northwesterly through a series of five dams and ponds in North Andover for approximately 2 miles to its confluence with the Merrimack River.

B. Description of Dam and Appurtenances. The Lake Cochichewick Outlet dam consists of a cut-stone gate structure built into the lake shoreline. A gated underground conduit conveys flow from the gate structure approximately 150 ft. beneath the shoreline and beneath an abandoned railroad embankment into the southeast end of Stevens Pond. The 4-ft. high by 5-ft. wide timber gate is controlled by a mechanism locked behind steel doors in the gate structure. The dimensions of the underground conduit are unknown. A sketch plan of the dam site is included in Appendix C-1.

There is no discernible dam embankment or spillway structure at the site. The original configuration of the lake shoreline and its natural outlet, prior to construction of the gate structure, conduit and railroad embankment, is not known. It is probable that a low earth dam and the gate structure were constructed about 1837. At the time, the top of the embankment may have been about El. 114.8, the elevation of the stone platform adjacent to the gate structure. Some time later, a railroad embankment was constructed across the dam, masking its original geometry. In effect, the railroad embankment raised the dam at least 15 ft. and broadened its base considerably. Construction of the railroad included a cut-stone masonry underpass tunnel 11.5 ft. in height, shown in Photograph No. 11. This tunnel would serve as an "emergency spillway" outlet in the event water in Lake Cochichewick rose above about El. 113.6.

C. Size Classification. Lake Cochichewick Outlet dam has an estimated maximum storage of 2,380 acre-feet and a maximum height of 12 ft. Storage of from 1,000 to 50,000 acre-feet and/or a height of from 40 to 100 ft. classifies a dam in the "intermediate" size category, according to guidelines established by the Corps of Engineers. Although the height of Lake Cochichewick Outlet dam is much less than 40 ft., it is classified as an "intermediate" size dam by virtue of its storage capacity.

D. Hazard Classification. Lake Cochichewick is currently classified as having a "high" hazard potential in the Corps of Engineers National Inventory of Dams. Computations based on "Guidance for Estimating Downstream Dam Failure Hydrograph", included in Appendix D, confirm this classification. In the event of a dam failure, the Mill Pond Condominiums about 2,500

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM
LAKE COCHICHEWICK OUTLET DAM
MA 00278

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region.

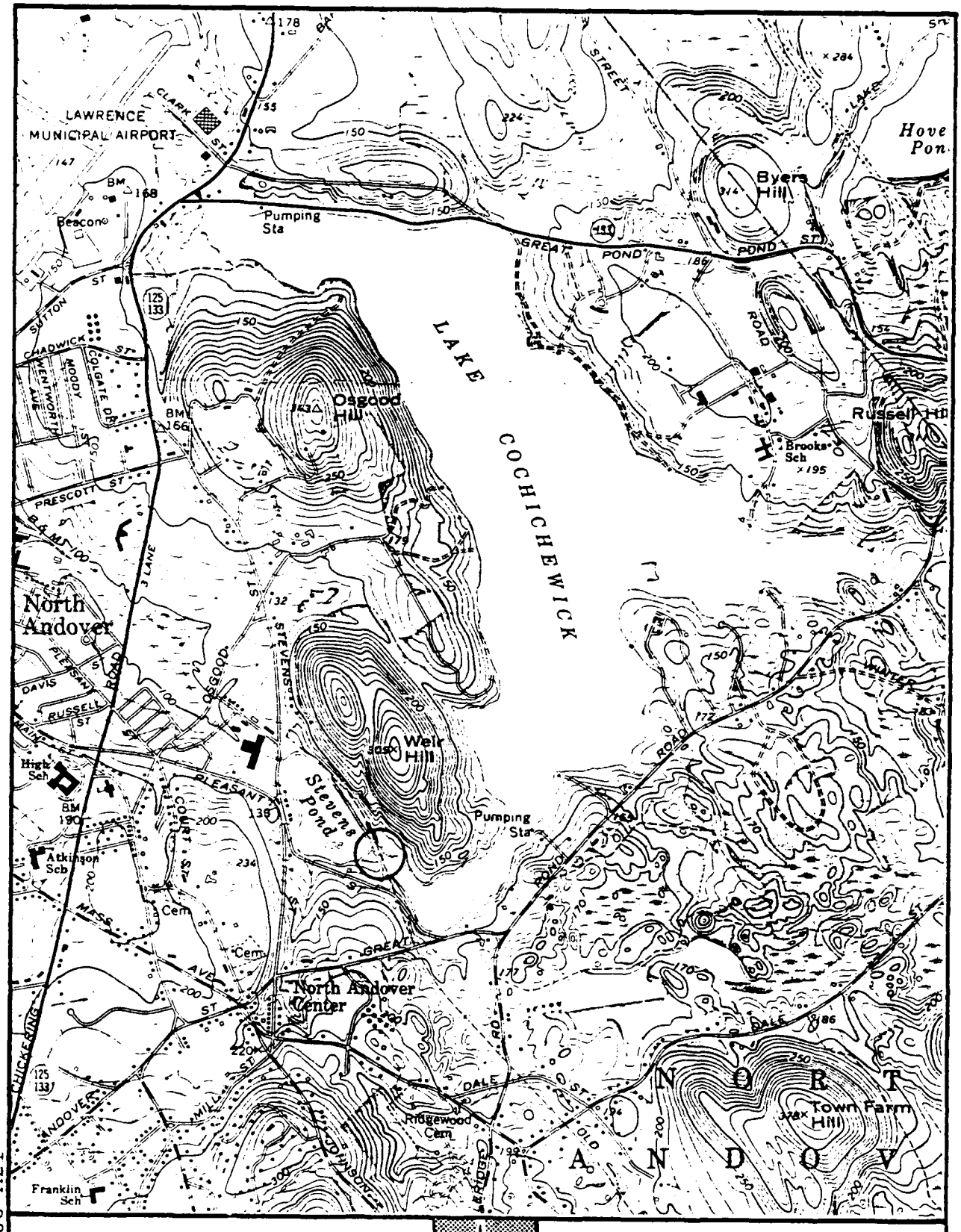
Haley & Aldrich, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed were issued to Haley & Aldrich, Inc. under a letter dated 26 April 1978 from Colonel Ralph T. Garver, Corps of Engineers. Contract No. DACW33-78-C-0301 has been assigned by the Corps of Engineers for this work. Camp, Dresser & McKee, Inc. was retained as consultant to Haley & Aldrich, Inc. on the structural, mechanical/electrical and hydraulic/hydrologic aspects of the Investigation.

B. Purpose. The primary purposes of the National Dam Inspection Program are to:

1. Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

2. Encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.

3. To update, verify and complete the National Inventory of Dams.



FILE NO. 4160 A21

DAM: Lake Cochichewick Outlet

IDENTIFICATION NO. MA 00278

N

LOCATION MAP
USGS QUADRANGLE
SOUTH GROVELAND, MA.
APPROX. SCALE: 1"= 2000'

accomplished:

A. Operation and Maintenance Procedures. The following remedial work should be undertaken by the Owner:

1. Place earth fill adjacent to the gate structure to restore ground surface grades to the elevation of the stone platform, El. 114.8.

2. Refill all joints in the gate structure with cement mortar as necessary.

3. Clean gate structure doors of rust and repaint.

4. Realign stones in the wall of the entrance channel and fill joints with mortar.

5. The outlet conduit should be checked for blockage and cleared if found to be blocked.

The Owner should prepare an operations and maintenance manual for the dam. The manual should contain an inspection check list for the gate, approach channel, outlet structure, and outlet conduit. It should spell out how the equipment and the structures are to be maintained and what to do in case of emergency. It should be specific in identifying the reservoir water elevation at which the gate is to be opened and under what conditions it is to be closed. The Owners of the downstream control structures should be listed as well as the method for notifying the Owners prior to the opening of the gate.

Because the dam is classified as having a "high" hazard potential, the Owner should also develop a written emergency preparedness plan and warning system to be used in the event of impending failure of the dam. The plan should be developed in cooperation with local officials and downstream inhabitants.

7.4 ALTERNATIVES

Not applicable.

APPENDIX A

INSPECTION TEAM ORGANIZATION AND CHECK LIST

VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INSPECTION PROGRAM

Dam: Lake Cochichewick Outlet

Date: 3 October 1978

Time: 0900-1100

Weather: Partly Cloudy and Cool (50's F.)

Water Surface Elevation Upstream: El. 107.9 MSL

Stream Flow: Not applicable (Outlet gate closed)

Inspection Party:

Harl P. Aldrich, Jr. - Soils/Geology
Haley & Aldrich, Inc.
Roger H. Wood - Structural/Mechanical
Camp, Dresser & McKee, Inc.
Charles E. Fuller - Hydraulic/Hydrologic
Camp, Dresser & McKee, Inc.

Present During Inspection:

Joseph J. Borgesi, Superintendent of Public Works,
North Andover, MA
Richard A. Brown, Haley & Aldrich, Inc.
Donna L.B. D'Amore, Camp, Dresser & McKee, Inc.

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Lake Cochichewick Outlet Dam DATE: 3 Oct. 78

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
General	There is no obvious embankment forming the dam and no spillway, as discussed in Sections 1.2B and 1.3B
Crest Elevation	114.8 on cut stone platform at gate structure
Current Pool Elevation	107.9
Trespassing	Frequent foot traffic near gate structure
Vegetation	Grassed downstream of gate structure brush and trees on right and left sides of gate structure
Sloughing or Erosion of Slopes or Abutments	Areas adjacent to gate structure eroded to El. 113.6 (1.2 ft. below top of dam)
Rock Slope Protection - Riprap Failures	None
Unusual Embankment or Downstream Seepage	Not applicable
Piping and Boils	Not applicable
OUTLET WORKS	
1. Approach Channel	
a. Obstructions	None observed
b. Channel bottom	Not visible
c. Channel wells	Granite masonry walls with upper mortared. Most of the mortar is missing. Voids present in left and right walls and blocks are displaced. Soil has eroded behind right wall
d. Log boom, screens, etc	None - water level gage cut into right wall
e. General structural condition	Due to presence of voids, displaced blocks and loss of backfill, the condition of the intake is considered fair
2. Control Facility	
a. Screens, stop logs	None observed

VISUAL INSPECTION CHECK LIST
NATIONAL DAM INSPECTION PROGRAM

DAM: Lake Cochichewick Outlet Dam DATE: 3 Oct. 78

AREA EVALUATED	CONDITION
b. Gate	Timber gate, 5 ft. wide, depth unknown. Timber stem. Rack and pinion lifting device with ratchet catch. Operated by pry bar. Gate operational. Condition good
c. Mechanical-Electrical	None
d. Substructure	Mortared stone masonry - good condition
e. Superstructure	Mortared stone masonry with few open joints. Steel doors have rust present and some bullet holes.
f. Seepage	Efflorescence present on interior face of walls
3. Outlet	
a. Conduit	The conduit is not visible for inspection. It is reported to be stone masonry conduit.
b. Outlet structure	Only the upper portion of the headwall is above water. Stones are displaced and the general conditions indicate eroded materials may be partially obstructing the outlet

FILE NO. 4160

APPENDIX B

LIST OF AVAILABLE DOCUMENTS AND PRIOR INSPECTION REPORTS

LIST OF AVAILABLE DOCUMENTS
LAKE COCHICHEWICK OUTLET DAM

DOCUMENT	CONTENTS	LOCATION
County inspection reports	Summary of 23 inspections by county engineers office from 10 November 1916 through 25 January 1968	Essex County Engineers Office, 32 Federal Street, Salem, MA 01970 and Appendix B-2
State inspection report	State inspection report dated 21 October 1971	Mass. Dept. of Environmental Quality Engineering, Division of Water-ways, 100 Nashua St., Boston, MA 02114 and Appendix B-6
Operation records	Water level records for Lake Cochichewick	Town of North Andover, Department of Public Works, 384 Osgood St., North Andover, MA 01845

0127-5-C
D. G. R. S. P.

COUNTY OF ESSEX, MASSACHUSETTS
ENGINEERING DEPARTMENT

0127-5-C
SUB NUMBER
D. G. R. S. P.
Neg. Nos. 2126

Inspection of Dams, Reservoirs, and Stand Pipes

Inspector A. E. Woodbury Date Nov 10, 1916 *Classification 2

City or Town North Andover Location East of Stevens St. on Lake Cochichewick outlet

Owner Controlled by Mills on River below Use Storage

Include such details as cores, cut-off walls, paving, sodding, class of masonry, kind of cement, (nat. or port.) etc.

Material and Type Earth with granite culvert under Private Road and Railroad tracks to Pond below

Elevations in feet: above (+) or below (−) full pond or reservoir level. (Cross out what does not apply.)

For Dam
(Bed of stream below ..... Bottom of pond ..... Bottom of spillway ..... Top of dam ..... Top of flash boards .....
For Res. or S. P.
(~~Ground surface below~~ ..... ~~Bottom of res.~~ ..... ~~Level of over flow pipe~~ ..... ~~Top of res.~~

For dam
Length in ft. ..... Top width in ft. ..... Pond area ~~25~~ acres Area of watershed 5½ sq. mi.
For Res. or S. P.
~~Inside dimensions~~ ..... ~~Capacity~~ ..... ~~covered~~ ~~open~~

Length of overflow or spillway ..... Outlet pipes (size and nature) .....

~~Stand pipe thickness at base~~ ..... ~~diam. of riser head~~ ..... ~~Diam.~~

Foundation and details of construction .....

Constructed by and date .....

Recent repairs and date .....

Evidence of leakage .....

Condition Good ~~S. P. when painted~~

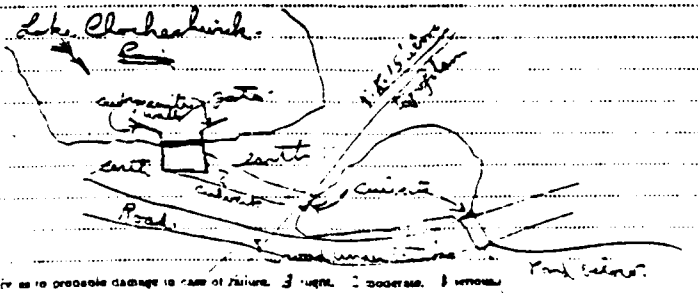
Topography of country below Pond

Nature, extent, proximity, etc. of buildings, roads or other property in danger if failure should occur .....

Plans and data secured or available .....

Use separate sheet for sketches if necessary.

Notes, sketches, sections, etc. Dam is 15' high 6' of water now Max. height of water 11' gate is made of wood 6' wide ? Diag. ? =



*Classify as to probable damage in case of failure. 3 slight, 2 moderate, 1 serious.

B-2

North Andover D. 6

1917, March 26. Watershed 5.5 sq. m. Max. Ht. 15.0 ft. Apparent condition, Good.

1926, Oct. 27. R. R. Evans Inspec. with Mr. F. C. Hatch, Jr., Engineer for M. T. Stevens & Sons, Co. This dam at the outlet of the lake is in fair condition. It is little higher than the level of the ground between it and the railroad which is here on a high embankment. There is no spillway in the dam but water level of the pond is controlled by a gate. This dam has been in existance many years, and the gate has proved sufficient in all cases. Since the water level is carried about four feet below the top of the dam and the area of the pond is about one square mile with some five and one-half square miles of water shed, it seems reasonable that the pond would furnish sufficient storage to take care of floods. Mr. R. A. Hale of Lawrence who has had advisory engineering supervision of this property for many years states that the pond has always provided sufficient storage so that there are no floods on the stream below, and he knows of no records of stream flow. An over-flow of the dam would apparently not cause any very serious consequences as the railroad forms a higher dam with under-pass about fifteen feet wide through which water would flow to the pond below..

1926 Report to Co. Comm. This dam is of earth with rubble walls and is little higher than the level of the ground between it and the railroad which is here on a high embankment. There is no spillway in the dam but water level of the pond is controlled by a gate. This dam has been in existence many years, and the outlet has proved sufficient in all cases. Since the water level is carried about four feet below the top of the dam and the area of the pond is about one square mile with some five and one-half square miles of water shed, it seems reasonable that the pond would furnish sufficient storage to take care of floods. Mr. R. A. Hale of Lawrence who has had advisory engineering supervision of this property for many years states that the pond has always provided sufficient storage so that there are no floods on the stream below, and he knows of no records of stream flow. An overflow of the dam would apparently not cause any very serious consequences as the railroad forms a higher dam with underpass about fifteen feet wide through which water would flow to the pond below. The dam is in fair condition.

1929, Nov. 19. C. C. Barker, Insp. with Mr. Hatch, Jr. Failure of this dam would cause no damages as the water would flow into the pond below and this slowly as the railroad embankement would retard the water. This dam is in good condition. There have been no changes since the last inspection and conditions are the same.

1929 Report to Co. Comm. See general statement as to dams on small stream flowing out of Lake Chochechiwick.

1931, Oct. 5. C. C. Barker, Insp. with Mr. Austin Stevens, Mechanic. This dam is in good condition. There have been no changes since the last inspection and conditions are the sage.

1931 Report to Co. Comm. See general statement as to dams on the stream flowing out of Lake Chochechiwick.

North Andover D. 6

1933, Oct. 25, C. C. Barker, Insp. Mr. Hatch Jr., did not go to this dam with me. The dam is in good condition and there have been no changes since the last inspection.

1933 Report to Co. Comm. Safe and in reasonably good condition.

1935 Sept. 30, C. C. Barker, Insp. Mr. Hatch did not go to this dam with me. Some of the stone on the upper east wing wall are being reset. This dam is in good condition, and there has been no change. The pond is low. The water level is 102.5.

1935 Report to Co. Comm. Safe and in reasonably good condition.

1937 July 19, C.C.Barker, Insp. Mr. Hatch did not go to this dam with me. This dam is in good condition the stones are well cemented and there has been no change. The water level is elev. 103.5.

1937 Report to Co. Comm. Safe and in reasonably good condition.

1939 August 25, C.C.Barker, Insp. This dam is in good condition, and there has not been any change. The water level is elev. 103.0

1939 Report to Co. Comm. Safe and in reasonably good condition.

1941 Sept. 26, C.C.Barker, Insp. This dam is in good condition. There has not been any change. The water level is elev. 102.0.

1941 Report to Co. Comm. Safe and in reasonably good condition.

1943 Aug. 18, S.W.Woodbury, Insp. I went to this dam alone. Tide gauge reads 133.5. The north wing wall is cracked and the end has settled a little. Conditions here appear to be about the same.

1943 Report to Co. Comm. Safe and in reasonably good condition.

1945 Aug. 21, S. W. Woodbury, Insp. Gave a copy of the notice to Mr. Perkins, and went to the dam alone. Water level today: Very high 136.1 ? (Town base) (Tide gauge hard to read). 106.2 Stevens Mill Base; Condition of the dam good.

1945 Report to Co. Comm. Safe and in reasonably good condition.

1947 Sept. 19, S.W.Woodbury, Insp. Gave a copy of the notice to Mr. Perkins and went to dam alone. No repairs since last inspection. Water level today: About 1 ft. below top of opening (impossible to read gauge now) Water is very low. Condition of the dam is the same.

1947 Report to Co. Comm. Safe and in reasonably good condition.

1949 Sept. 21, S.W. Woodbury, Insp. Gave a copy of the notice to Mr. Perkins and went to dam alone. Water level today: about 1 ft. below top of opening. Condition of the dam is the same.

North Andover D. 6

1949 Report to Co. Comm. Safe and in reasonably good condition.

1951 Oct. 10, E.H.Page, Insp. Gave a copy of the notice to Mr. Perkins and went to the dam alone. Water level today: 2" below top of opening. Didn't get into the gatehouse, but Mr. Perkins says it is in good condition. He has cleaned it three times this year.

1951 Report to Co. Comm. Safe and in reasonably good condition.

1953 Oct. 2, E.H.Page, Insp. Went to dam alone. Water level today: About 12" below opening. Condition of the dam is the same.

1953 Report to Co. Comm. Safe and in reasonably good condition.

1954, May 27, E.H.Page, Insp. Elev. of water: 3'-1" below granite foundation of gate ho. Condition of dam: Same.

1955, Nov. 18, E.H.Page, Insp. Elev. of water: 12;-1" on new guage. Condition of dam: Same.

1955 Report to Co. Comm. Safe and in reasonably good condition.

1957 Dec. 17, E.H.Page, Insp. No repairs since last inspection. Elev. of water: 6.0 Condition: Same.

1957 Report to Co. Comm. Safe and in reasonably good condition.

1959, Sept. 21, E.H.Page, Insp. Condition: Same.

1959 Report to Co. Comm. Safe and in reasonably good condition.

1961 Nov. 29, E.H.P. & P.D.K. Insps. Condition: Safe. Same.

1961 Report to Co. Comm. Safe and in reasonably good condition.

1963 No report.

1963 Report to Co. Comm. Safe and in reasonably good condition.

1965 June 16, 1966. P.D.K Insp. Condition same.

1965 Report to Co. Comm. Safe and in reasonably good condition.

1967 Jan. 25, 1968. P.D.K. Insp. Condition same.

1967 Report to Co. Comm. Safe and in reasonably good condition.

D. 6 —

NORTH ANDOVER
5-5-210-6

L.E. WILKINSON 10/21/71 3

OUTLET OF LAKE COCHICHEWICK. BEGIN ON STEVENS ST. AT PLEASANT ST. — TAKE PLEASANT ST. SOUTHWEST 0.25 MI. TO DRIVE AT NORTH SIDE OF PLEASANT ST. — TAKE DRIVEWAY NORTHERLY ACROSS TOP OF STEVENS POND AND UNDER R.R. EMBANKMENT TO DAM AT OUTLET OF LAKE COCHICHEWICK
J.P. STEVENS & CO. INC. STEVENS ST. N. ANDOVER

LAKE COCHICHEWICK IS PLEASURE POND & WATER SUPPLY FOR TOWN OF NORTH ANDOVER

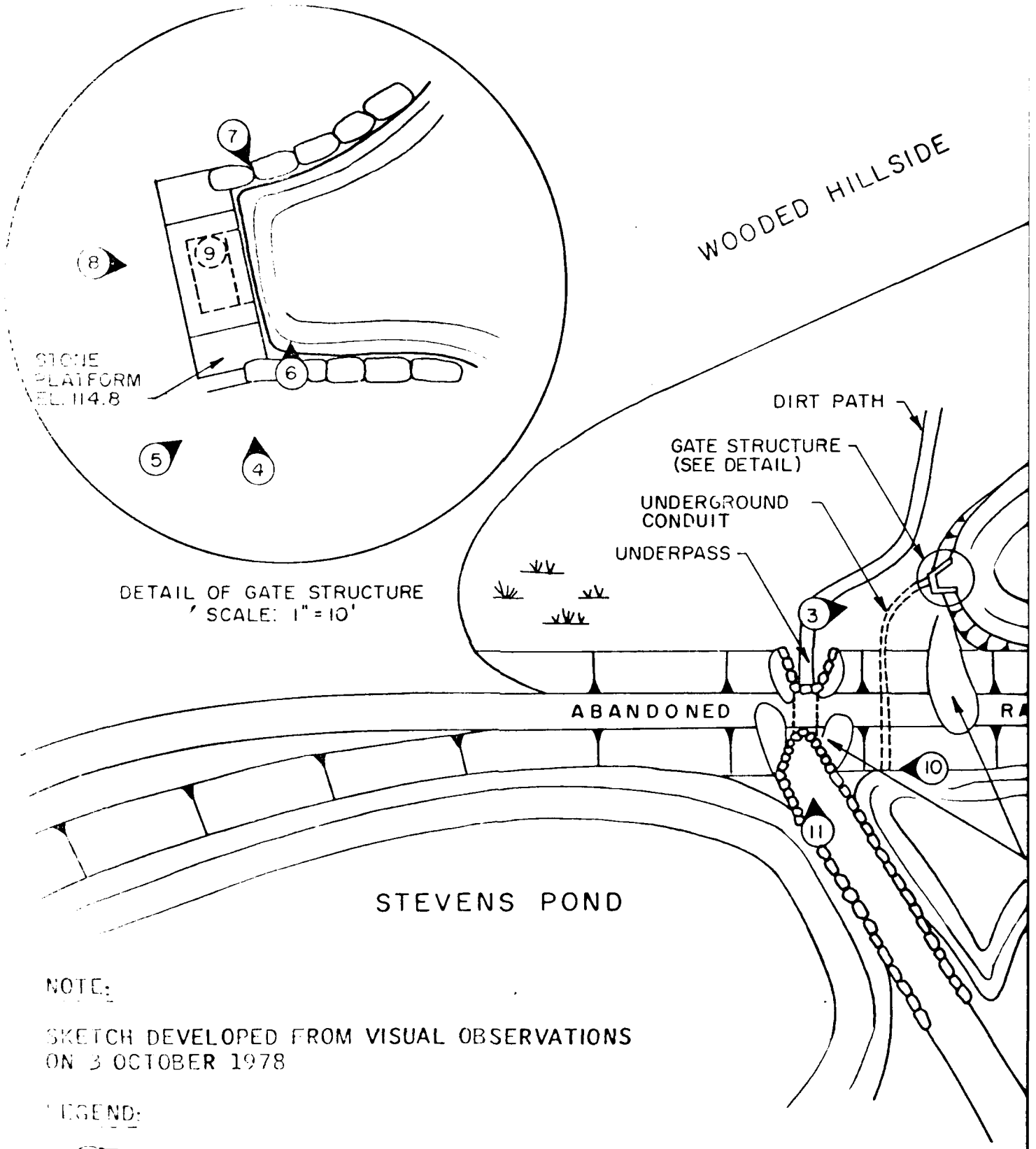
CUT GRANITE GATEWAY AND SOME EARTHWORK —

NINE — WATER LEVEL TO-DAY IN POND IS 7.5 FT. BY GAUGE MARKS IN GRANITE WINGWALL.

SAFE AND IN EXCELLENT CONDITION

APPENDIX C
SELECTED PHOTOGRAPHS OF PROJECT

No.		Roll	Frame	Page No.
1.	Overview of Lake Cochichewick Outlet dam	C19	8	vii
2.	Upstream view of gate structure	C19	7	C-2
3.	Downstream view of gate structure	20	11A	C-2
4.	Left side of gate structure	20	1A	C-3
5.	Gate structure and left approach channel wall	C19	15	C-3
6.	Right approach channel wall	C19	11	C-4
7.	Left approach channel wall	C19	12	C-4
8.	Gate being operated	C19	2	C-5
9.	Gate control	C19	9	C-5
10.	Conduit outlet to Stevens Pond	C19	18	C-6
11.	Cut-stone underpass tunnel through railroad embankment	C19	16	C-6



DETAIL OF GATE STRUCTURE
SCALE: 1" = 10'

NOTE:

SKETCH DEVELOPED FROM VISUAL OBSERVATIONS
ON 3 OCTOBER 1978

LEGEND:

(4) PHOTO NO. AND DIRECTION OF VIEW.

HALEY & ALDRICH, INC
CAMBRIDGE, MASSACHUSETTS

CAMP DRESSER & McKEE
Environmental Engineers
Boston Mass

CLIENT Holyoke Airport JOB NO 5141-2-ET PAGE 4
PROJECT Cocomo Pond CSO DATE CHECKED 11-2-88 DATE 6/10/88
DETAIL Lake Cochichewick CHECKED BY RFW COMPUTED BY AJD

Calculation of the PMF

From "Maximum Probable Flood Peak Flow Rates"

Drainage Area Size = 5.7 sq. mi.
Terrain: Rolling to Mountainous

PMF = 2000 cfs/sq. mi = 11,400 cfs

*Compare this value with that value generated from the SCS TR-149 Method

CN Analysis

Hydrologic Soil Group: C/D

Land Usage	CN	Area (acres)	Area x CN
Lake Cochichewick	100	570	57000
Streets, Roads	98	65	6370
Residential	92	80	7360
Marshland	98	240	23520
Open Spaces	77	2693	207361
		3648	300811

Weighted CN = 300811 / 3648 = 82.46

Say 82

Length Watercourse

200' - steep, mountainous overland flow (Δelev. = 161')
7600' - marshland, then defined watercourse (Δelev. = 39')

Travel Times
- overland: Velocity = 1.5 f/s, Time = 9 min
- marshland and defined watercourse: Velocity = 1.07 f/s
  Time = 119 min

Time of Concentration = T_c = 127 min (2.1 hours approximately)

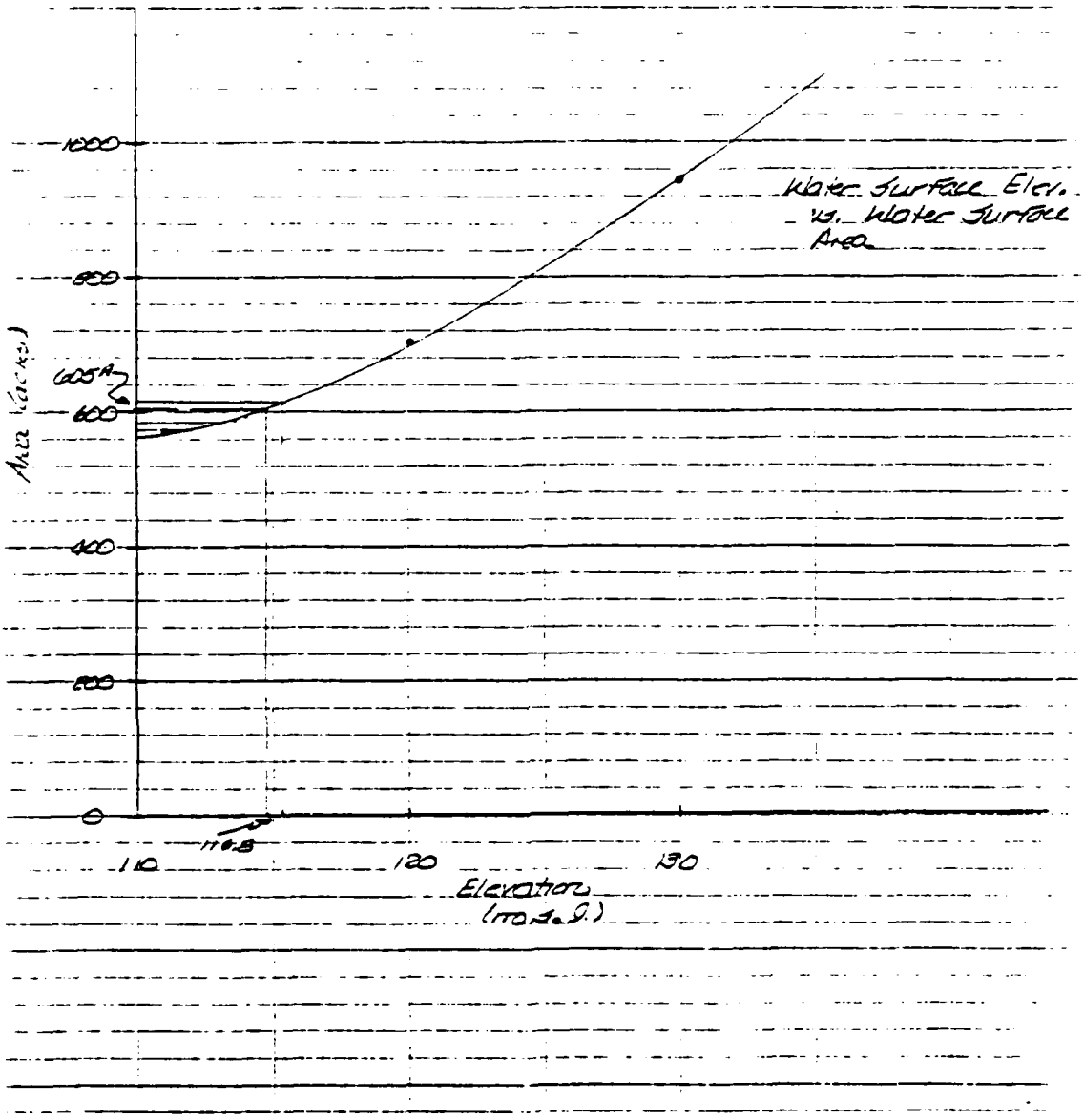
"R" Time = 7 min (1.27 hours approximately)

CAMP DRESSER & McKEE
Environmental Engineers
Boston Mass

CLIENT
PROJECT
DETAIL

JOB NO
DATE CHECKED 11-2-78
CHECKED BY

PAGE
DATE
COMPUTED BY



CAMP DRESSER & McKEE
Environmental Engineers
Boston Mass

CLIENT [illegible] JOB NO [illegible] PAGE 2
PROJECT [illegible] DATE CHECKED 11-2-78 DATE 10 [illegible]
DETAIL [illegible] CHECKED BY [illegible] COMPUTED BY [illegible]

Size Classification

Height Dam = 11 feet (estimated)

Storage:

Elevations
Top of Dam: 114.8'
Low Point of Dam: 113.6'
Bottom of Pond: ~103'
Pond Water Surface Areas
Top of Dam: 605 A

Storage (at elev. 114.8) = $\frac{1}{3}$ x 11 x 605 = 2380 Ac-ft.

∴ Height = 11 feet < 40 feet
Storage: 1000 < 2380 < 50,000

∴ Size Classification is INTERMEDIATE by virtue of Storage.

Hazard Classification

Currently classified as "high" hazard by the DOE Dam Safety Division. Because of the location of Hill Pond Condominiums, initially assume the hazard remains at high.

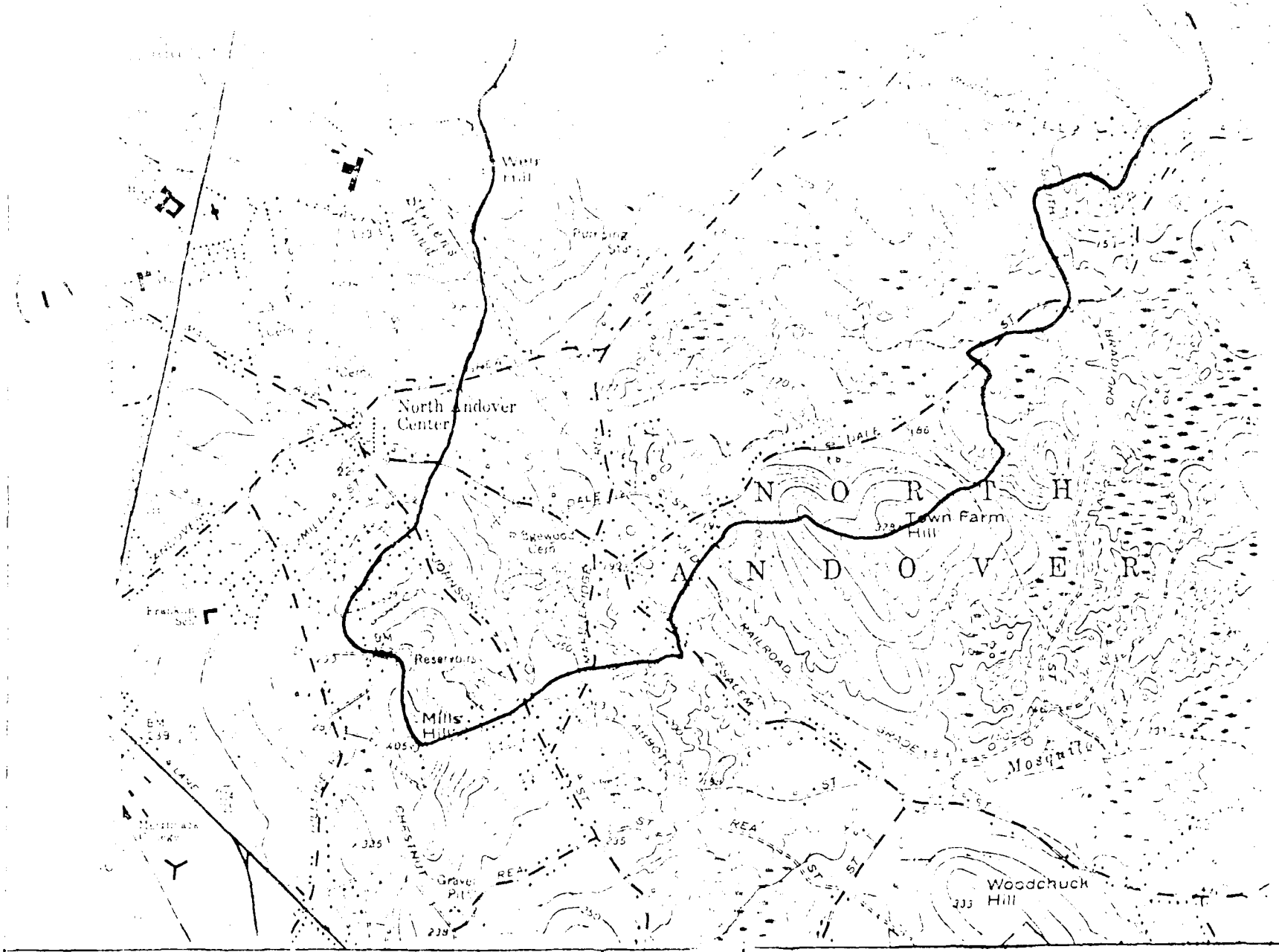
Test Flood

Size: Intermediate ∴ Test Flood is the PMF
Hazard: High

Initially assume the PMF as the Test Flood.

Record Floods

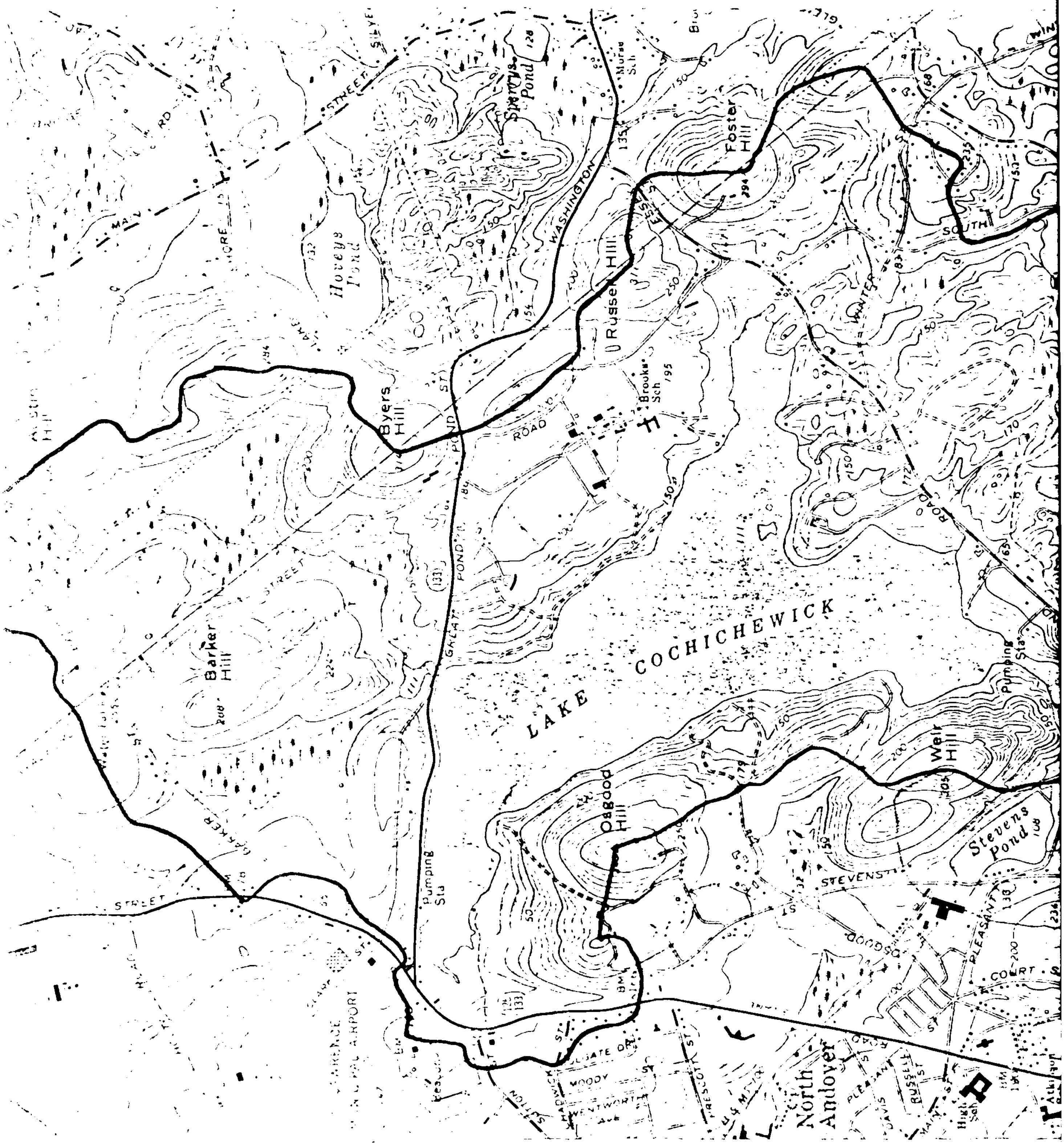
[illegible] = 113.6 ft = 3000 cfs
on 1 April 1951 as reported by owners.



CAMP DRESSER & McKEE INC.
Consulting Engineers
Boston, Mass.

LAKE COCHICHEWICK DRAINAGE AREA
Scale: 1:24,000

D-1



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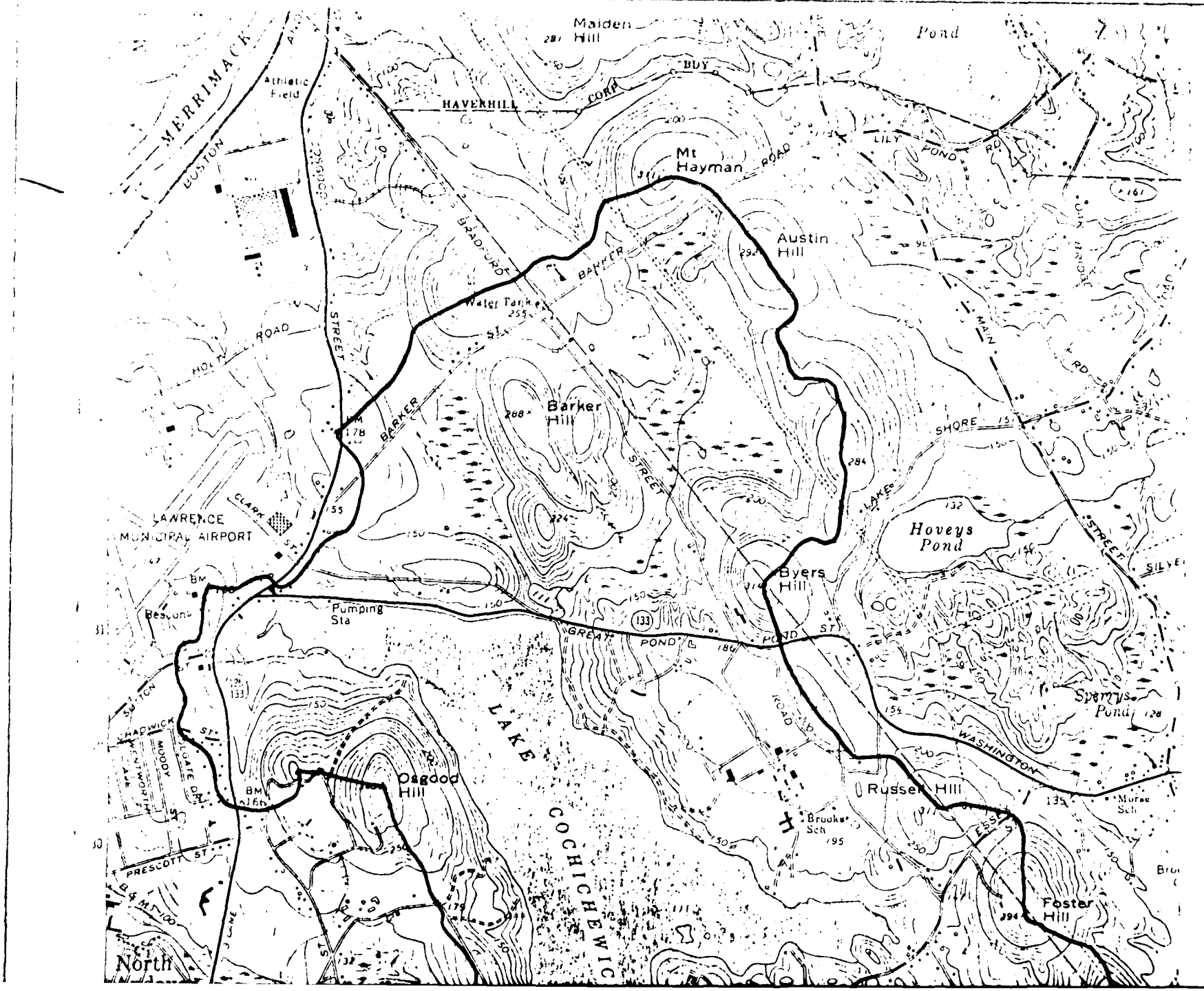
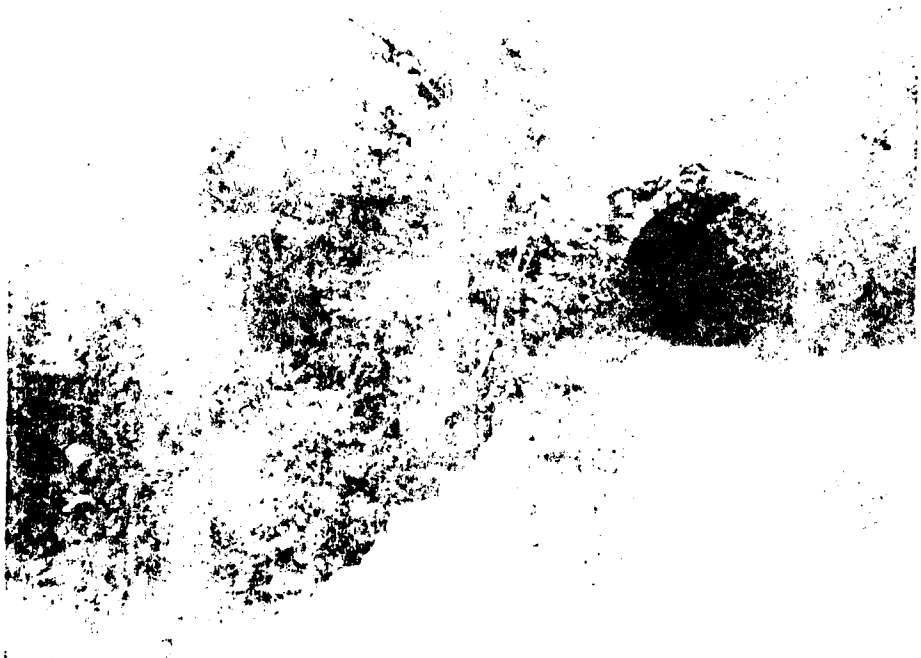


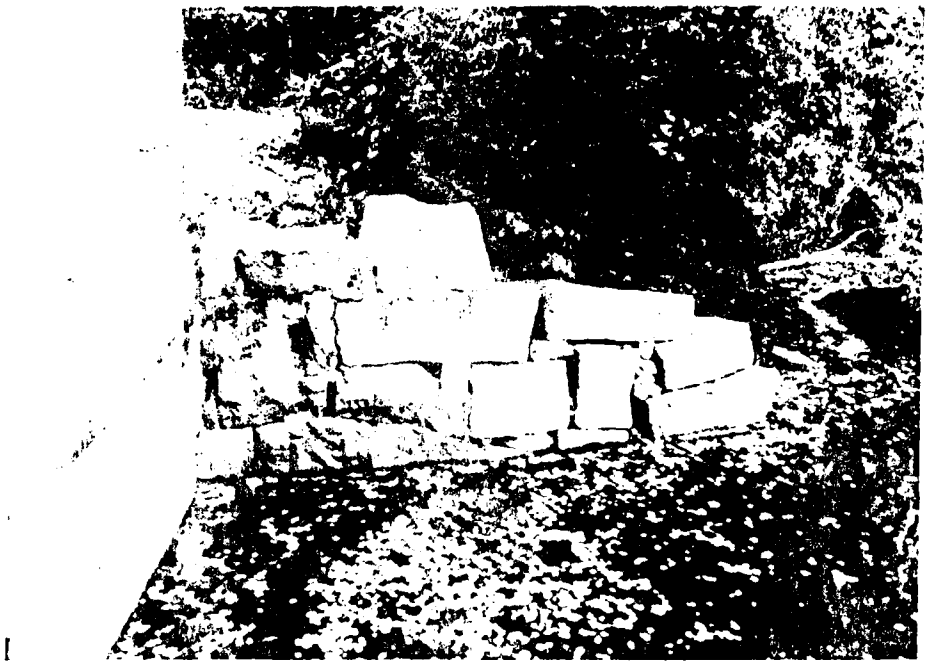
GOVERNMENT EXPENSE

APPENDIX D
OUTLINE OF DRAINAGE AREA AND HYDRAULIC COMPUTATIONS

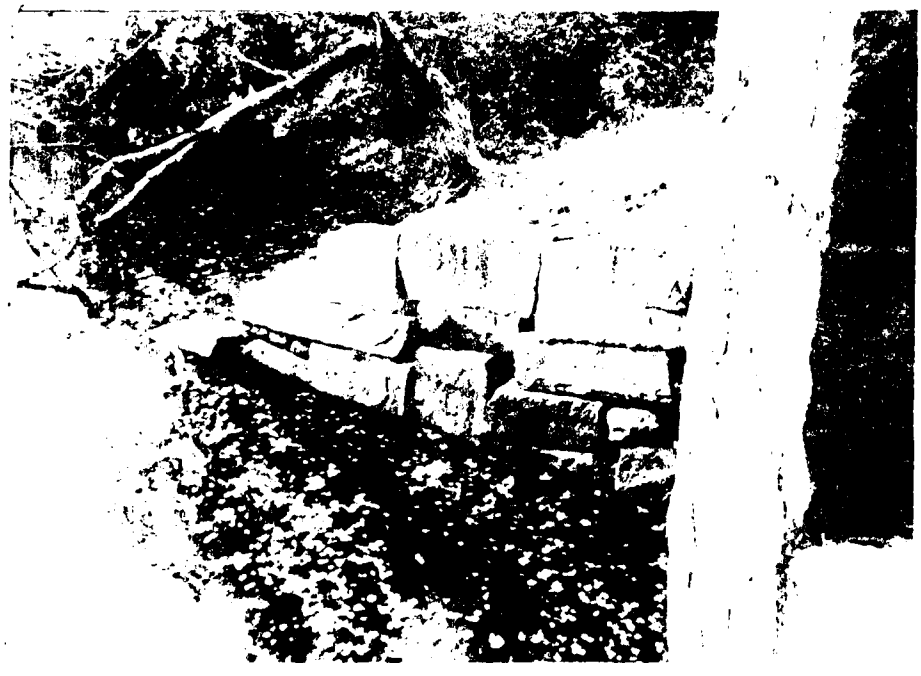


8. Gate being operated

9. Gate control

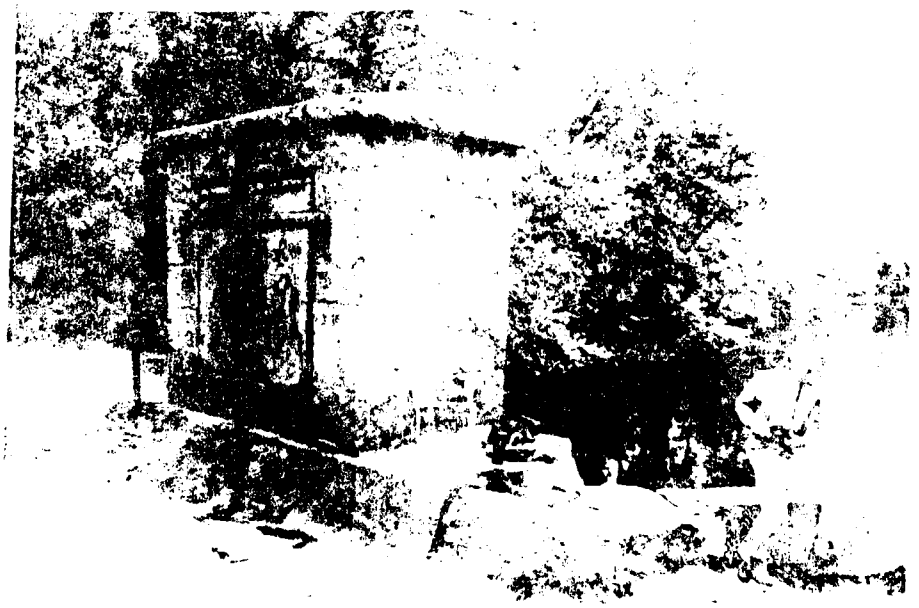


c. Right approach channel wall

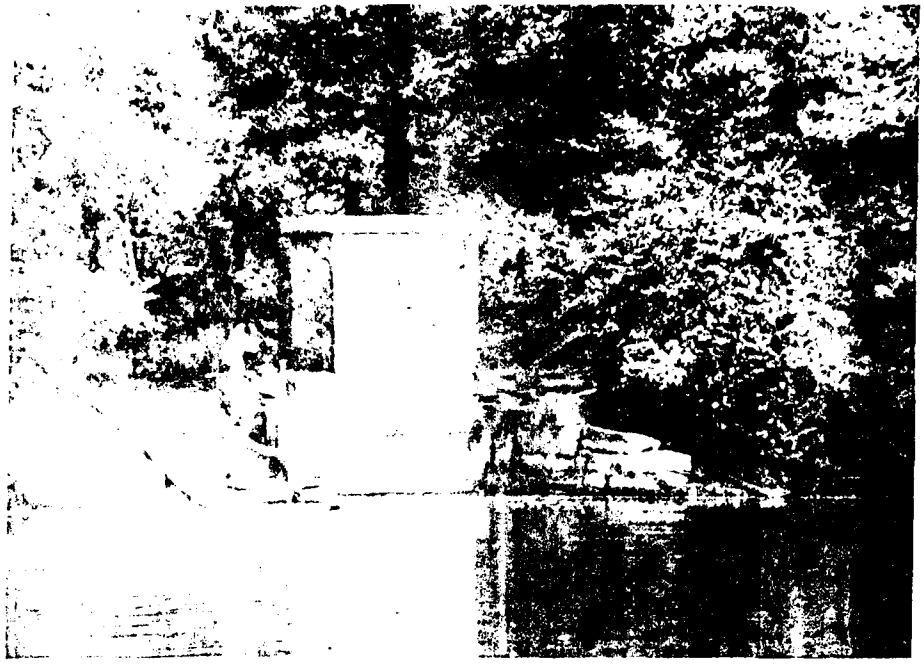


d. Left approach channel wall

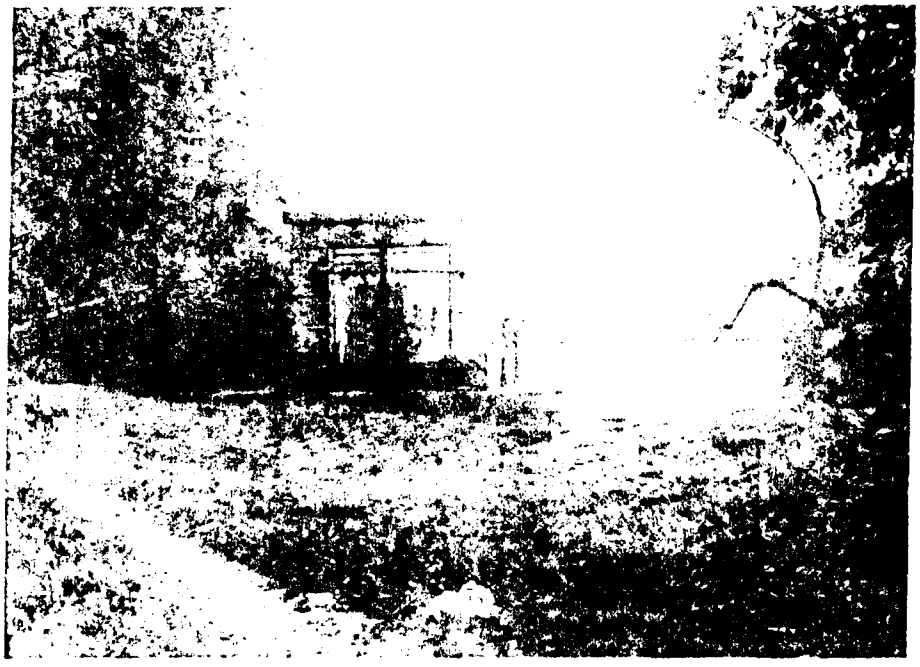
Left side of gate structure



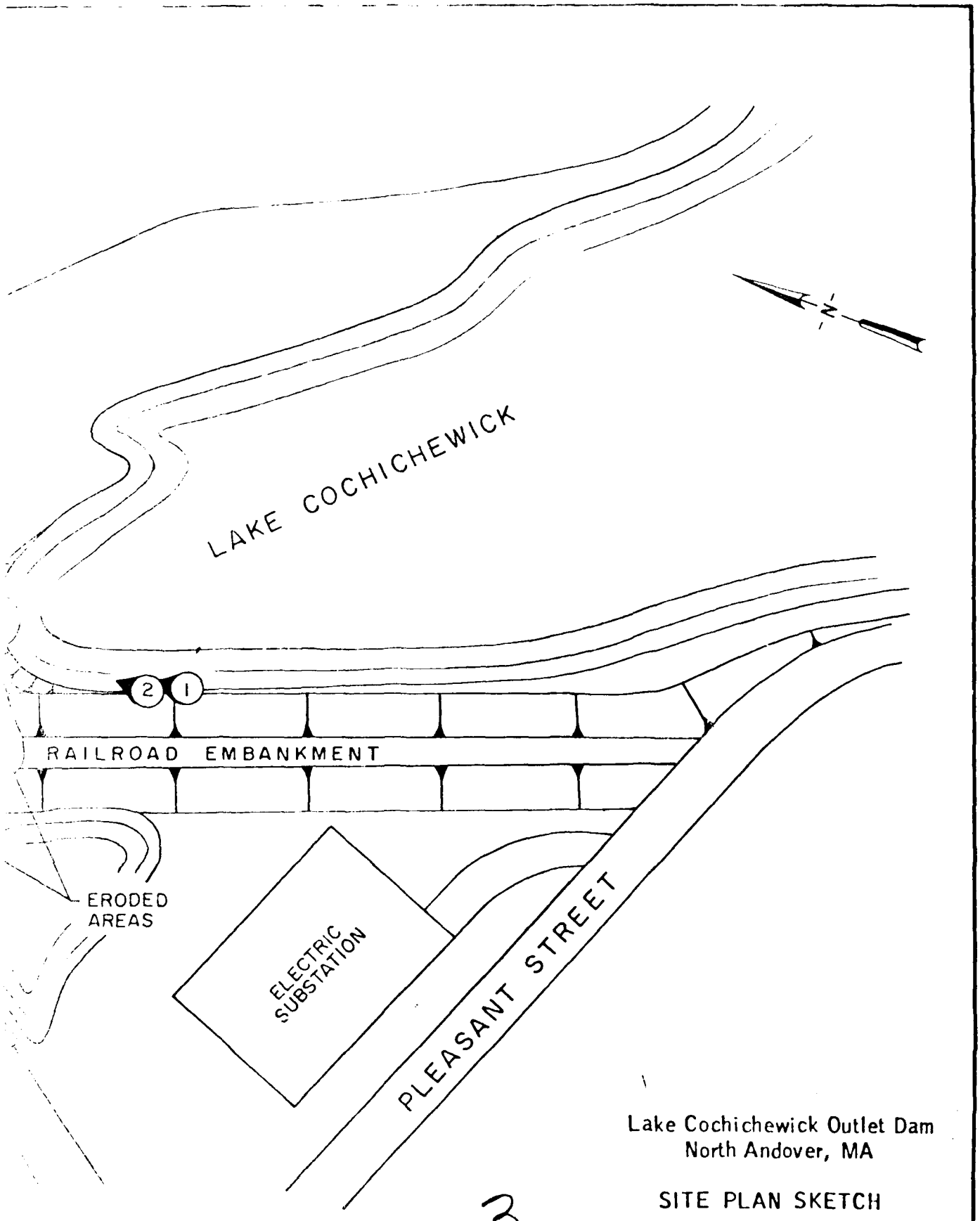
Gate structure and left approach channel wall



2. Upstream view of gate structure



3. Downstream view of gate structure



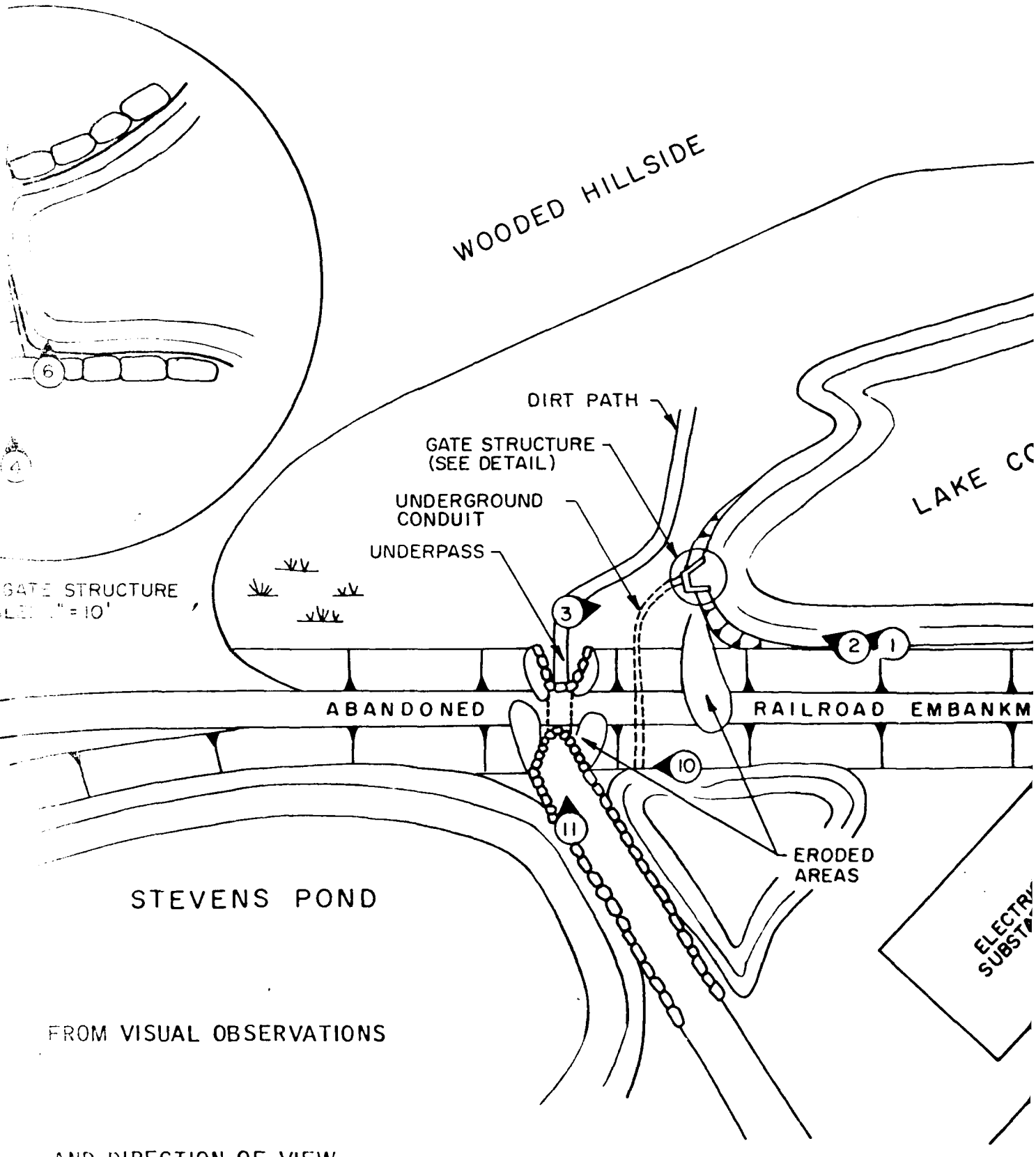
Lake Cochichewick Outlet Dam
North Andover, MA

SITE PLAN SKETCH

Scale: 1"=100' December 1978

3

C-1



FROM VISUAL OBSERVATIONS

AND DIRECTION OF VIEW.

2

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CLIENT [illegible]
PROJECT [illegible]
DETAIL [illegible]
JOB NO [illegible]
DATE CHECKED [illegible]
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PAGE [illegible]
DATE [illegible]
COMPUTED BY [illegible]

Calculation of the PMF (continued)

$\Delta D = 0.4\,L = 0.4 \times 76\,min = 30.4\,min$, say 30 min

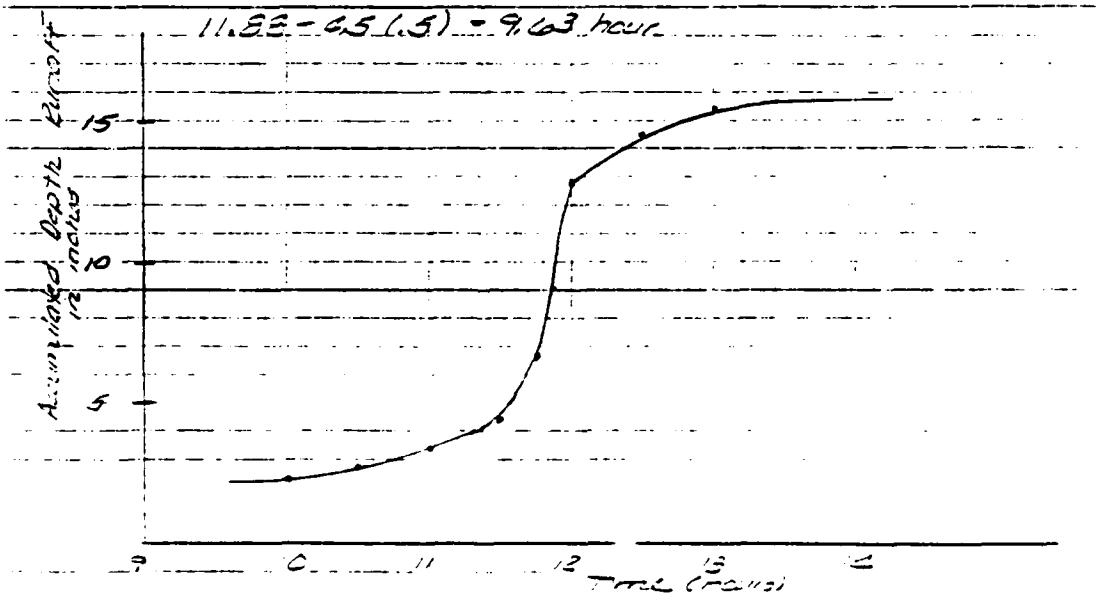
$t_r = 3.5$ hours

Rainfall = 23" in 24 hours

Time (hours)	A_i/A_t	Mass P (inches)	Mass Q (inches)
10.0	.181	4.16	2.34
10.5	.204	4.69	2.80
11.0	.235	5.41	3.45
11.5	.283	6.51	4.46
11.75	.327	8.90	6.72
12.0	.663	15.25	12.90
12.5	.735	16.91	14.53
13.0	.772	17.76	15.37

$S = \frac{1000}{CL} - 10 = \frac{1000}{22} - 10 = 2.195$

$11.83 - 4.5\,(.5) = 9.63$ hour



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PROJECT [illegible]
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JOB NO [illegible]
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Calc's for Instantaneous Peak Discharge

Increment	Time (Hours)	Mass Run-off (in.)	ΔQ (inches)	Δq (c.f.s.)	Y	YΔq (cfs)
	9.63	2.20				
ΔQ_1			0.15	273	0.2	55
	10.13	2.35				
ΔQ_2			0.45	819	0.4	328
	10.63	2.80				
ΔQ_3			0.80	1455	0.6	873
	11.13	3.60				
ΔQ_4			2.00	3638	0.8	2910
	11.63	5.60				
ΔQ_5			7.60	13824	1.0	13824
	12.13	13.20				
ΔQ_6			1.45	2638	.667	1760
	12.63	14.65				
ΔQ_7			0.65	1182	.333	394
	13.13	15.30				
						Σ 20,144 cfs

$$\Delta q = \frac{484\,A}{L + \frac{\Delta D}{2}} \, \Delta Q = \frac{484 \times 5.7}{1.267 + \frac{.5}{2}} \cong 1819 \, \Delta Q$$

Therefore, the PMF ≅ 20,200 c.f.s.

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CLIENT [illegible]
PROJECT [illegible]
DETAIL Lake [illegible]

JOB NO. [illegible]
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DATE [illegible]
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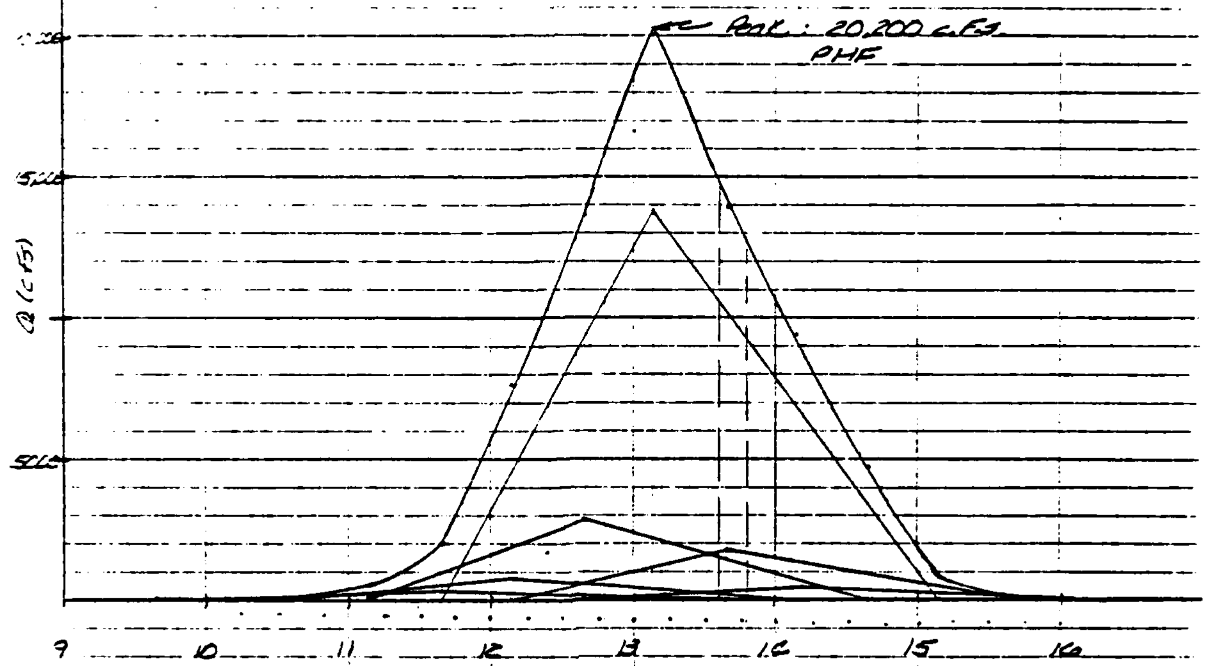

The peak value of the PHF, computed by the SCS TP 149, is the 20,200 c.f.s. The peak value according to the "[illegible] Flood Peak Flow Rates" Method was computed to be 11,400 cfs.

The 20,200 cfs value will be used as the peak value of the Test Flood.

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CLIENT: Haley and Aldrich
PROJECT: Lake Cochichewick
DETAIL: Lake Cochichewick
JOB NO: [illegible]
DATE CHECKED: 11-2-78
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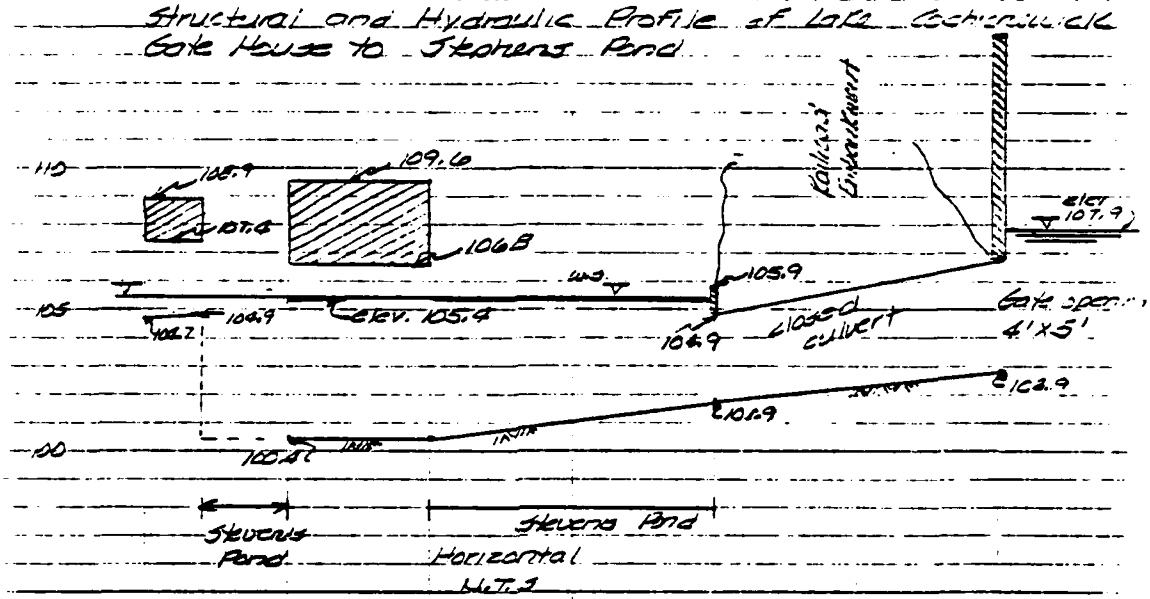
Structural and Hydraulic Profile of Lake Cochichewick Gate House to Stevens Pond



Initially assume gate open to see what ΔH in water surface varies with Flow.

Use Pressure Flow Formula: $Q = CA\sqrt{2gh}$

$C = 0.74$

$A_v = \frac{7 \times 3' - 4' \times 5'}{2} = 20.5^{\#}$

ΔH	Q cfs
1	122
2	172
3	211
4	244
5	272
6	300
7	322

Assume Average Flow = 200 cfs for expected ΔH values

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PROJECT [illegible]
DETAIL [illegible]

JOB NO [illegible]
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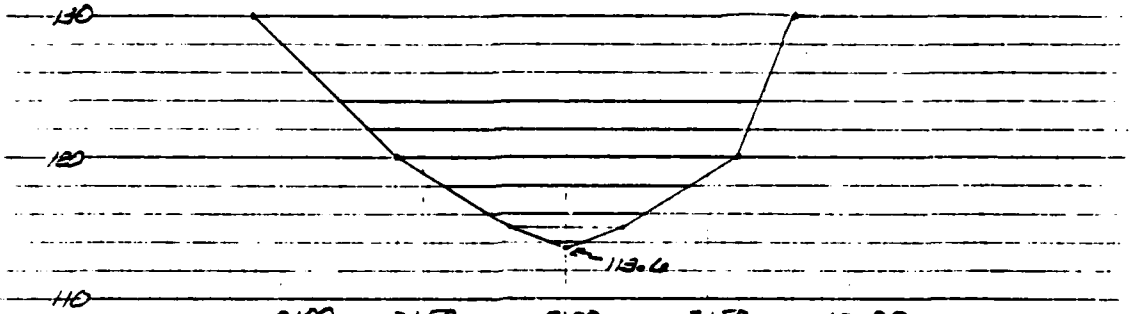
Top of Dam Profile (axis of spillway)



Looking downstream

For overland weir, L=250

Head	Elevation	Qweir	Qpeak
0.4	114	12	200
1.4	115	293	
2.4	116	904	
4.4	118	3508	
6.4	120	8587	
8.4	122	14417	
10.4	124	21.790	

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CLIENT Holyoke Airport
PROJECT Conceptual Design Report
DETAIL Lake Control Device

JOB NO. 561-2-RT
DATE CHECKED 11-2-78
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PAGE 10
DATE 10/12/78
COMPUTED BY AJC

Amount of Storage available between Water Surface Elevation 110 and Water Surface Elevation 113.6 is approximately 2300 Acre-A.

$S_{110 \to 113.6}$ = 2060 Acre-A = 89,793,600 A^3

$S_{110 \to 113.6}$ = 2300 Acre-A = 100,188,000 A^3

$S_{110 \to 115}$ = 2915 Acre-A = 126,977,400 A^3

$S_{110 \to 114.8}$ = 2796 Acre-A = 121,793,760 A^3

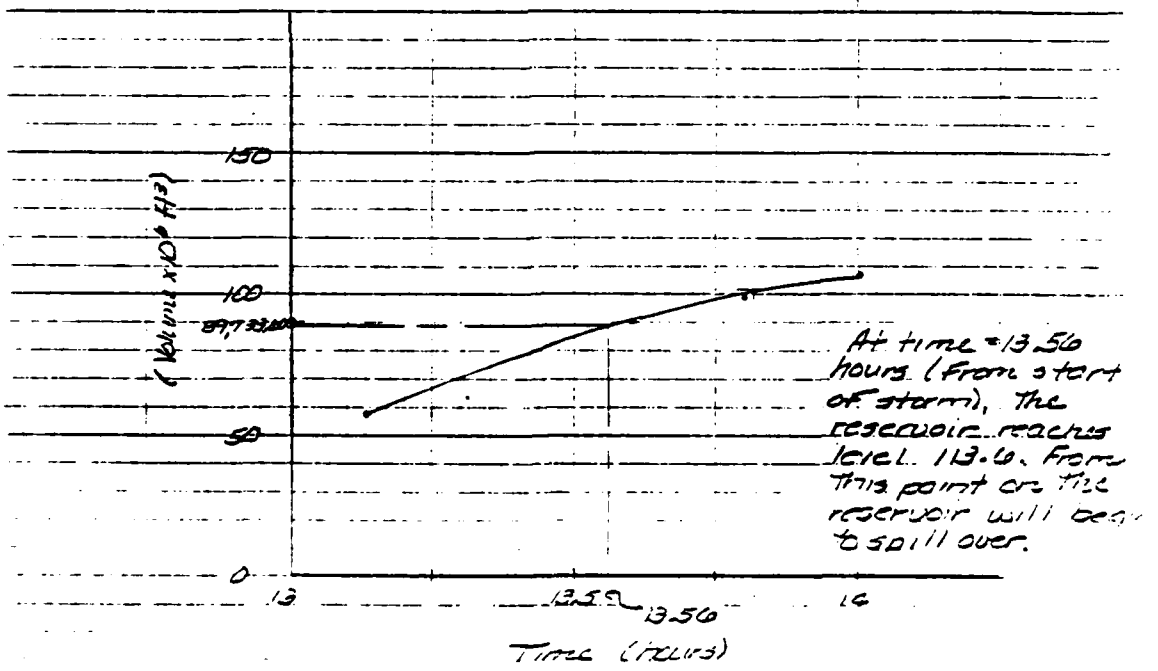
From inflow hydrograph, Volume of inflow at

Time = 13.13 ≅ 59,760,000 A^3

Time = 14.00 ≅ 107,640,000 A^3

Time = 13.60 ≅ 90,000,000 A^3

Time = 13.80 ≅ 99,900,000 A^3



At time = 13.56 hours (From start of storm), the reservoir reaches level 113.6. From this point on the reservoir will begin to spill over.

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Boston, Mass.

CLIENT Holyoke Airport
PROJECT Lateral Canal 1990
DETAIL Lake Routing

JOB NO 52-1-A-ET
DATE CHECKED 11-2-92
CHECKED BY [illegible]

PAGE 11
DATE 10/27/92
COMPUTED BY [illegible]

At time = 13.8 hours, we assume that the head gate is opened and have a maximum capacity of approximately 200 cfs (See page 8 of computations)

Head at Spillway (ft)	Water Surface Elev.	Res. Area (acres)	Gt. Out-Flow, Q (cfs)	Calc. Stor. S (acre-ft)	$\frac{1}{\Delta t}$ (cfs)	$\frac{S}{\Delta t} - \frac{Q}{2}$ (cfs)	$\frac{S}{\Delta t} + \frac{Q}{2}$ (cfs)
0	113.6	535	200	0	0	0	0
0.6	114	590	212	235	11374	11268	11480
1.2	115	607	493	834	40366	40119	40612
2.2	116	620	1100	1447	70035	69483	70587
2.4	118	655	3708	2722	131745	129891	133599

Δt = 15 mins = 900 s

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Boston, Mass.

CLIENT [illegible] JOB NO [illegible] PAGE 12
PROJECT [illegible] DATE CHECKED 11-2-78 DATE 10-12-78
DETAIL [illegible] CHECKED BY [illegible] COMPUTED BY [illegible]

	Time No.	Obs. Inflow	Average Inflow	$\frac{S}{\Delta t} - \frac{Q}{2}$	$\frac{S}{\Delta t} + \frac{Q}{2}$	Head Above Elev. 110'	Elevation (msl)	Outflow Q (cfs)
10	0	0	0	0	0	0	110.0	
	1	100	50					
	2	180	140					
	3	300	240					
11	4	500	400			increases	increases	0 outflow All is stored
	5	750	625					
	6	1500	1125					
	7	3100	2300					
12	8	5650	4375					
	9	8700	7175					
	10	11650	10175					
	11	15000	13325					
13	12	18500	16750					
	13	19100	18200					
	14	15900	17500			3.6	113.6	0
14	15	13100	14500	0	14500	4.10	114.10	240
	16	10600	11850	14153	26003	4.50	114.50	352
	17	8000	9300	25651	34951	4.81	114.81	438
	18	5700	6850	34513	41363	5.03	115.03	508
15	19	4500	5100	40855	45955	5.18	115.18	602
	20	2700	3600	45353	48953	5.28	115.28	663
	21	650	1675	48290	49965	5.31	115.31	684 ← Pk
	22	300	475	49281	49756	5.305	115.305	680
	23	200	250	49077	49327	5.29	115.29	671
16	24	0	100	48656	48756	5.27	115.27	659
	25	0	0	48094	48094	5.25	115.25	646
	26	0	0	47449	47449	5.23	115.23	632
	27	0	0	46817	46817	5.21	115.21	620
17	28	0	0	46198	46198	5.19	115.19	607
	29	0	0	45591	45591	5.17	115.17	595
	30	0	0	44997	44997	5.15	115.15	582
	31	0	0	44415	44415	5.13	115.13	570
18	32	0	0	43819	43819	5.11	115.11	558
	33	0	0	43261	43261	5.09	115.09	547
	34	0	0	42714	42714	5.07	115.07	536
	35	0	0	42178	42178	5.05	115.05	525

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CLIENT Highway Alaska
PROJECT National Park 1250
DETAIL Lake Cochichewick

JOB NO 3701-9-81
DATE CHECKED 11-2-82
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PAGE 12a
DATE 10/82
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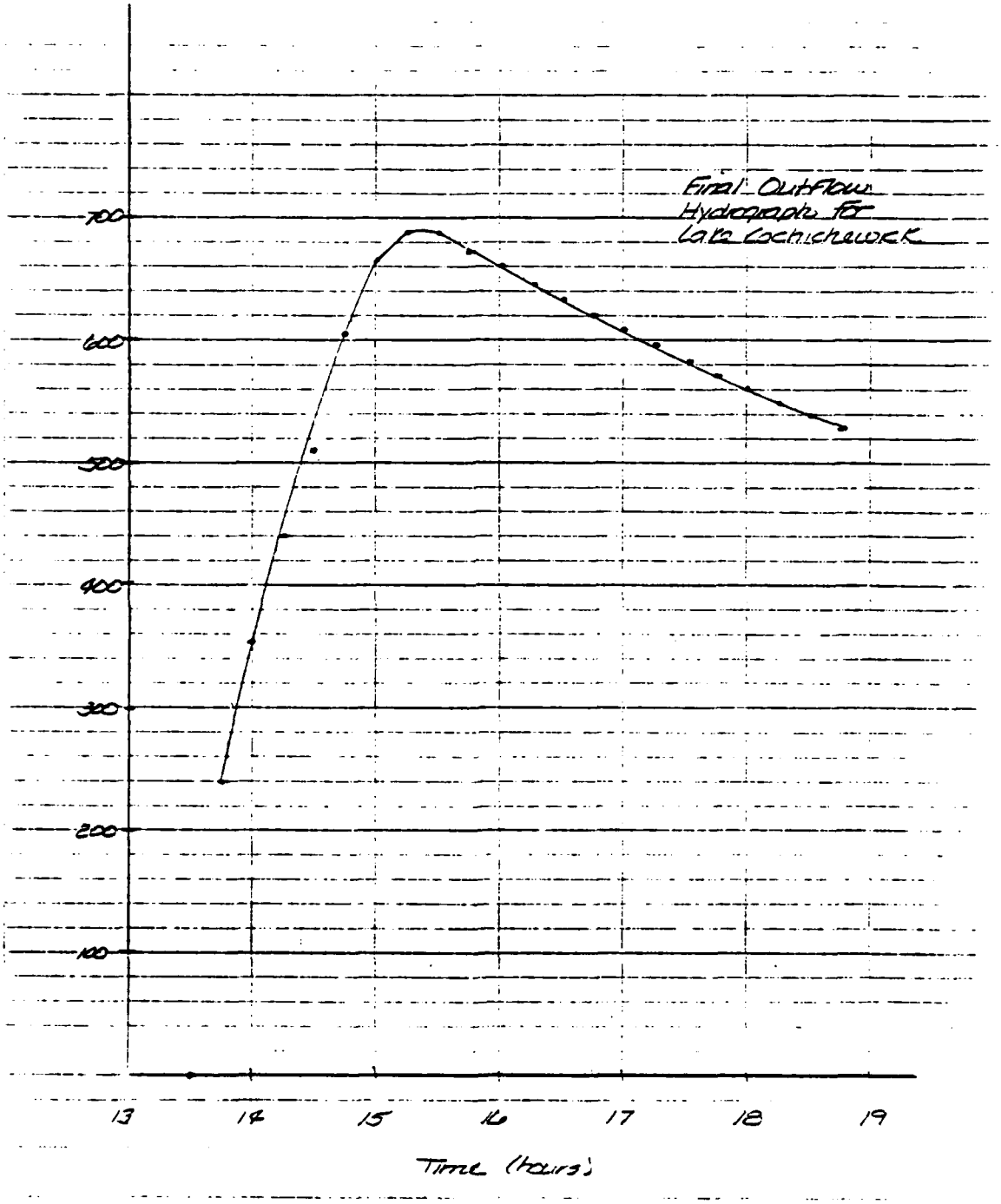

CAMP DRESSER & McKEE
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Boston, Mass.

CLIENT [illegible]
PROJECT National Dam Prog.
DETAIL Lake Cochichewick

JOB NO [illegible]
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DATE [illegible]
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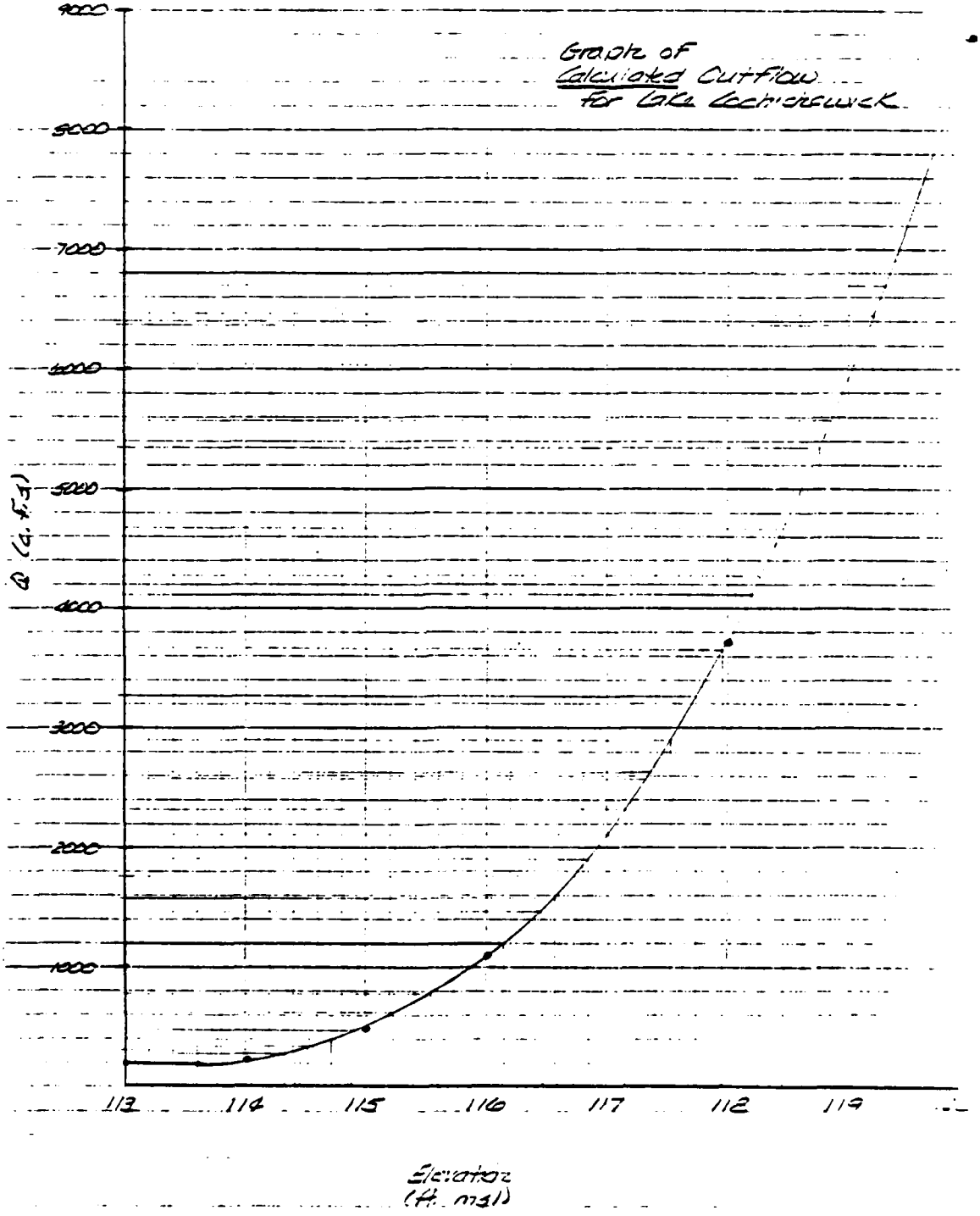

CAMP DRESSER & McKEE
Environmental Engineers
Boston, Mass.

CLIENT
PROJECT
DETAIL

JOB NO.
DATE CHECKED 11-2-78
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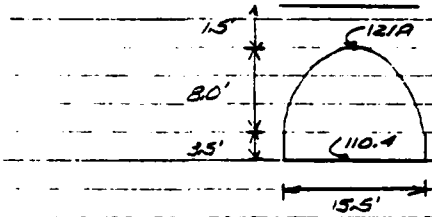
Cross-Section of Concrete Arch



n = .030

$A = 15.5 \times 3.5 + \frac{1}{2}\pi 12^2 = 154.8$ ft²

$WP = 15.5 + 2 \times 3.5 + \pi 3 = 47.6'$

$R = \frac{154.8}{47.6} = 3.25'$

Assume $S = (113.6 - 109.6)/300' = .0133$

$Q = \frac{1.486}{.030}(3.25)^{\frac{2}{3}}(.0133)^{\frac{1}{2}} 154.8 = 1943$ c.f.s.

Elev. (ft)	Head (ft)	A ft²	WP ft	R ft	S ft/ft	Q c.f.s.
110.4	0	0	0	0	.0133	0
112.4	2	31	19.5	1.590		241
114.4	4	62	20.5	3.02		740
116.4	6	92	24.5	3.76		1271
118.4	8	119	29.1	4.09		1740
120.4	10	139	35.1	3.96		1923
121.9	11.5	154.8	47.6	3.25		1943

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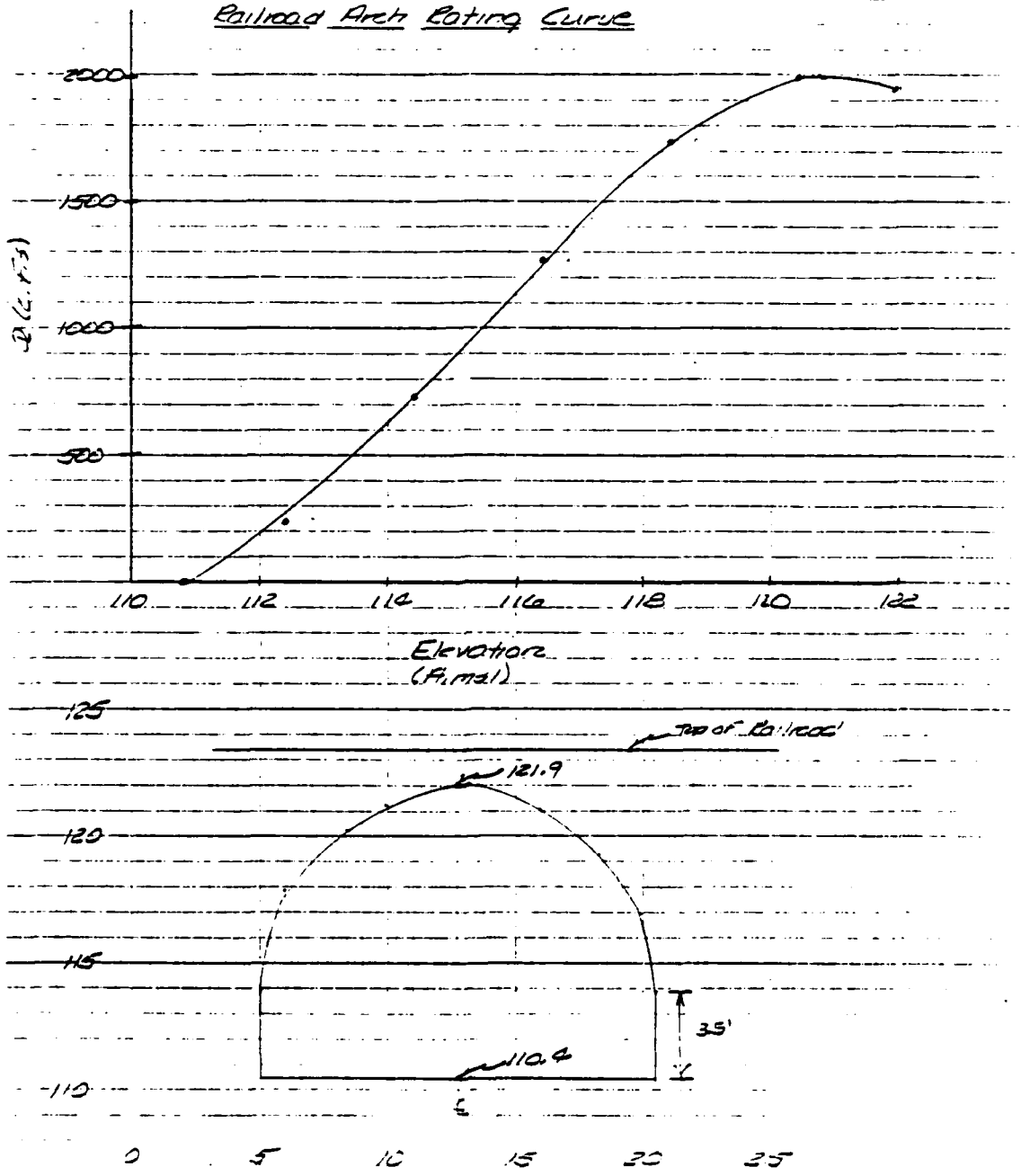
CLIENT [illegible] JOB NO. [illegible] PAGE 15
PROJECT [illegible] DATE CHECKED 11-2-78 DATE [illegible]
DETAIL [illegible] CHECKED BY [illegible] COMPUTED BY [illegible]

Railroad Arch Rating Curve



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Boston Mass

CLIENT _____ JOB NO _____ PAGE 5
PROJECT _____ DATE CHECKED 11-2-78 DATE _____
DETAIL Lake Cochichewick CHECKED BY _____ COMPUTED BY _____

Dam Failure Analysis

1. Reservoir Storage, S, at time of failure:

S = 2390 Acre-feet

2. $Q_{p_1} = \frac{8}{27} W_o \sqrt{g} Y_o^{3/2}$

Length Dam = 300'
W_o = 120' say Normal Water Level at 110'

$Q_{p_1} = \frac{8}{27} \times 120' \sqrt{32.2 \frac{ft}{s^2}} \times (6.0)^{3/2}$ ← (Elev. 114.8 - 108.8)

$Q_{p_1} \cong 2705$ cfs

Note: To consider 6 ft. of dam failure height, approximately 1.6 ft deep trench would be ripped out at the railroad arch.

Therefore, add 171 cfs to the capacities listed on Page 14 of computations. At Elev. = 123.6, the value of Q = 3855 cfs.

Assume failure occurred when Water Surface Elevation of Lake Cochichewick = 114.8 msl.

Therefore, Volume of Water Released
is $\left(2390 \text{ Acre-ft} - \frac{1}{3} \times 555 \times 5.8\right)$

= 1307 Acre-ft

1307 Acre-ft = 56,932,920 ft^3

This volume of water would cause a rise in Stevens Pond (extending downstream to the condominiums)

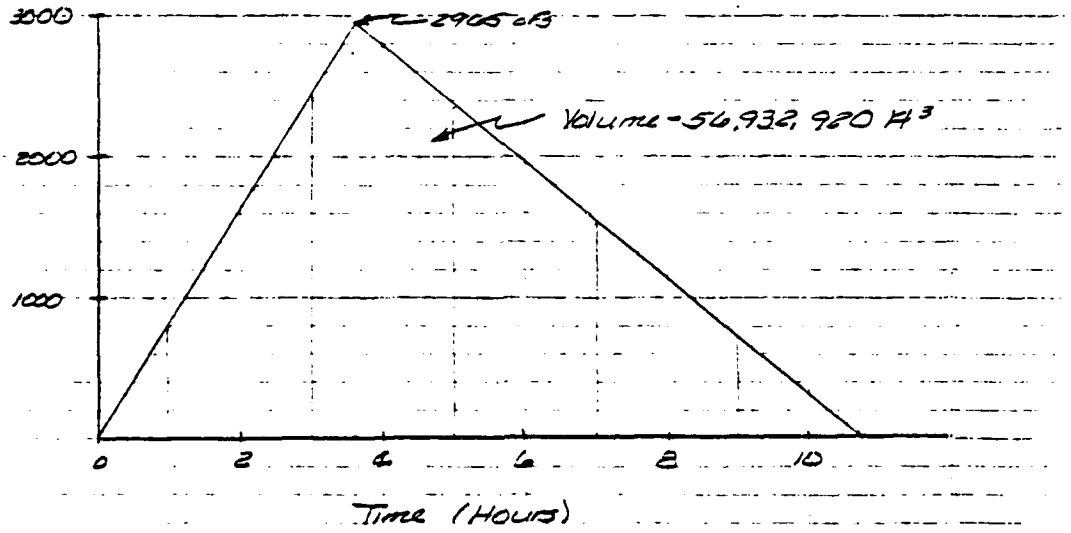
Starting WSE for Stevens Pond = 114.8 - 2.5
= 112.3

So, Assume 1307 Acre-ft spills into Stevens Pond with a triangular hydrograph and the peak flow occuring at $\frac{T}{3}$.

Sizing for Trapeze, 1/2 @ H = Ave.

$\left(\frac{T}{2}\right)(2905\ cfs) = 56,932,920\ ft^3$

T = 10.7 hours



Time (hrs)	Outflow (cfs)	Cum. Outflow (ft3)	Water Surface Elevation
0	0	0	114.80 Avg.
1	800	1,440,000	114.65
2	1620	5,932,000	114.30
3	2450	13,230,000	113.60
4	2780	23,904,120	112.60
5	2380	32,514,120	111.70
6	1950	40,435,920	110.85
7	1520	46,809,720	110.30
8	1110	51,538,320	109.70
9	700	54,790,920	109.25
10	300	56,554,920	109.05
10.7	0	56,932,920	109.00

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CLIENT [illegible]
PROJECT [illegible]
DETAIL [illegible]

JOB NO [illegible]
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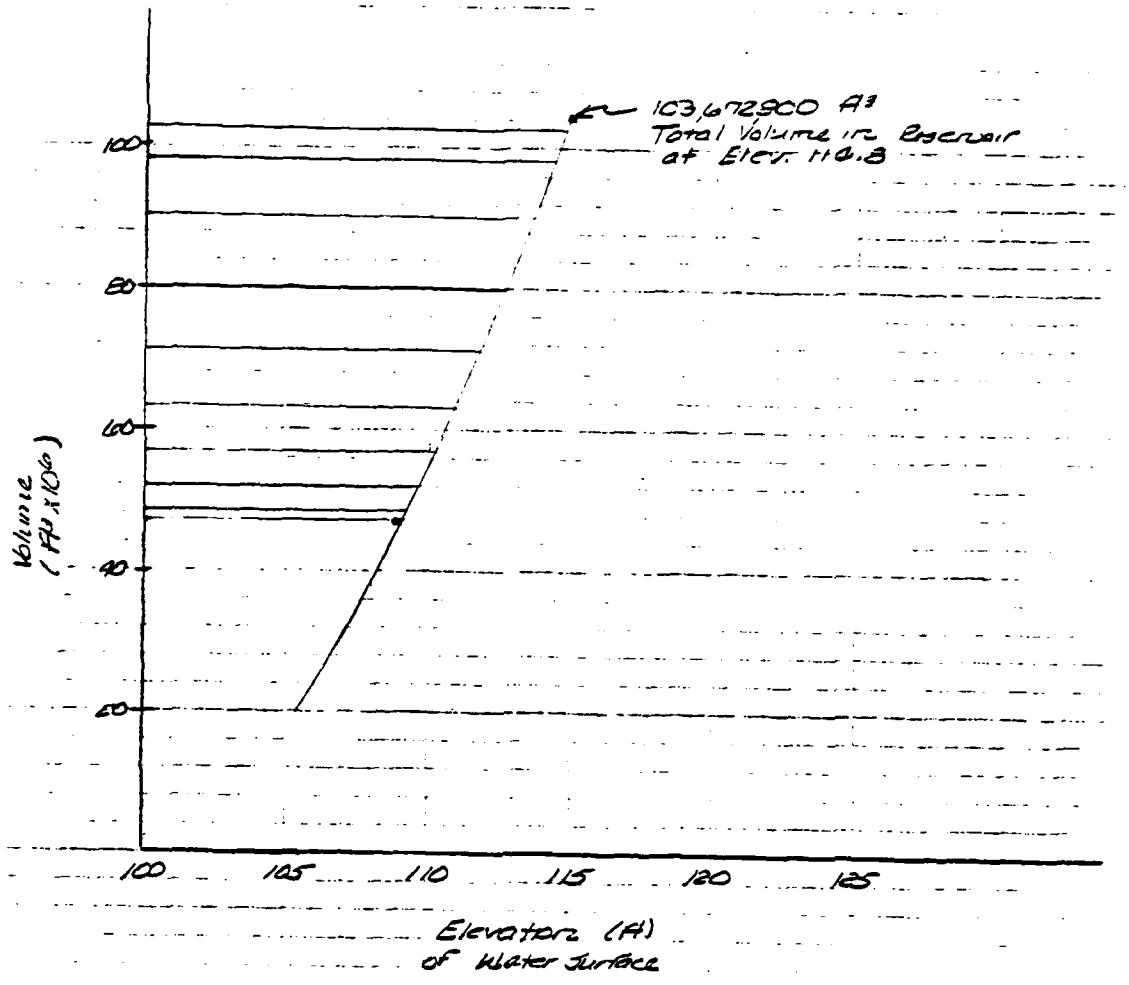
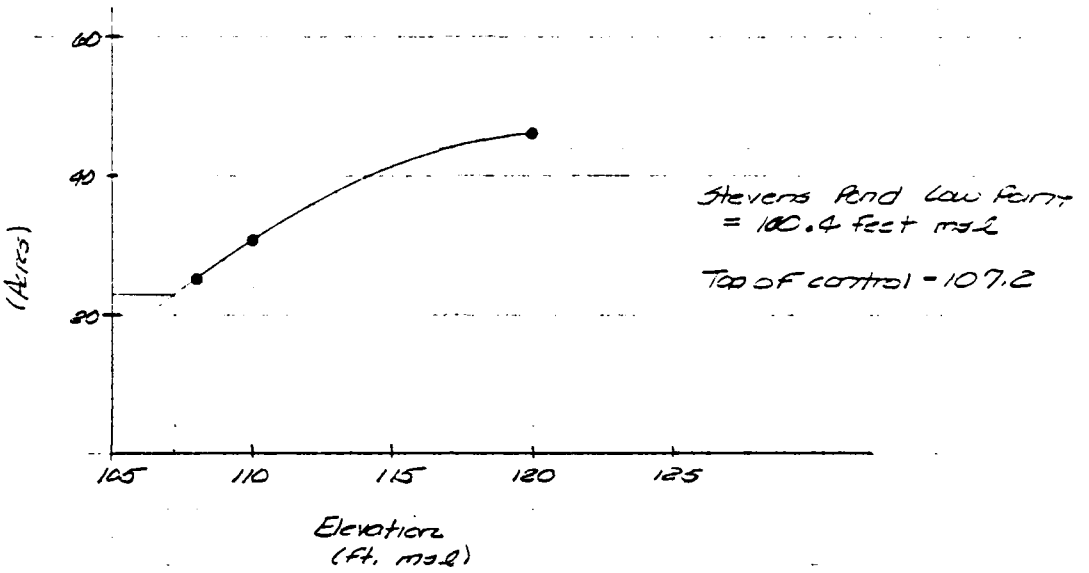


Stevens Pond

IF water surface elev. of Lake Cochichewick is at 114.8, then water surface elev. of Stevens Pond = 112.3



Storage up to elev. 107.2 = $\frac{1}{3} \times 6.8 \times 23 \approx 52$ Acre-feet
$\approx 2,270,928$ ft³

Storage up to elev. 110.0 = $52 - \left(\frac{23-31}{2}\right) 2.8 \approx 128$ Acre-ft
$\approx 5,575,680$ ft³

Storage up to elev. 120.0 = $128 + \left(\frac{31+46}{2}\right) 10 \approx 513$ Acre-Ft
$\approx 22,346,280$ ft³

As shown on page D-22, in the event of a dam failure the equilibrium point of the water surface elevations in Lake Cochichewick and Stevens Pond occurs at El. 114.30. At this point, the condominiums adjacent to the downstream end of Stevens Pond (west of Stevens St.) would experience a depth of 4.3 ft. of flooding, since the sill elevation of these structures is approx. El. 110.

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Environmental Engineers
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CLIENT Hairy and Aldrich
PROJECT Lathrop Dam Insp.
DETAIL Lake Cochichewick

JOB NO 561-2-RT
DATE CHECKED 11/12/82
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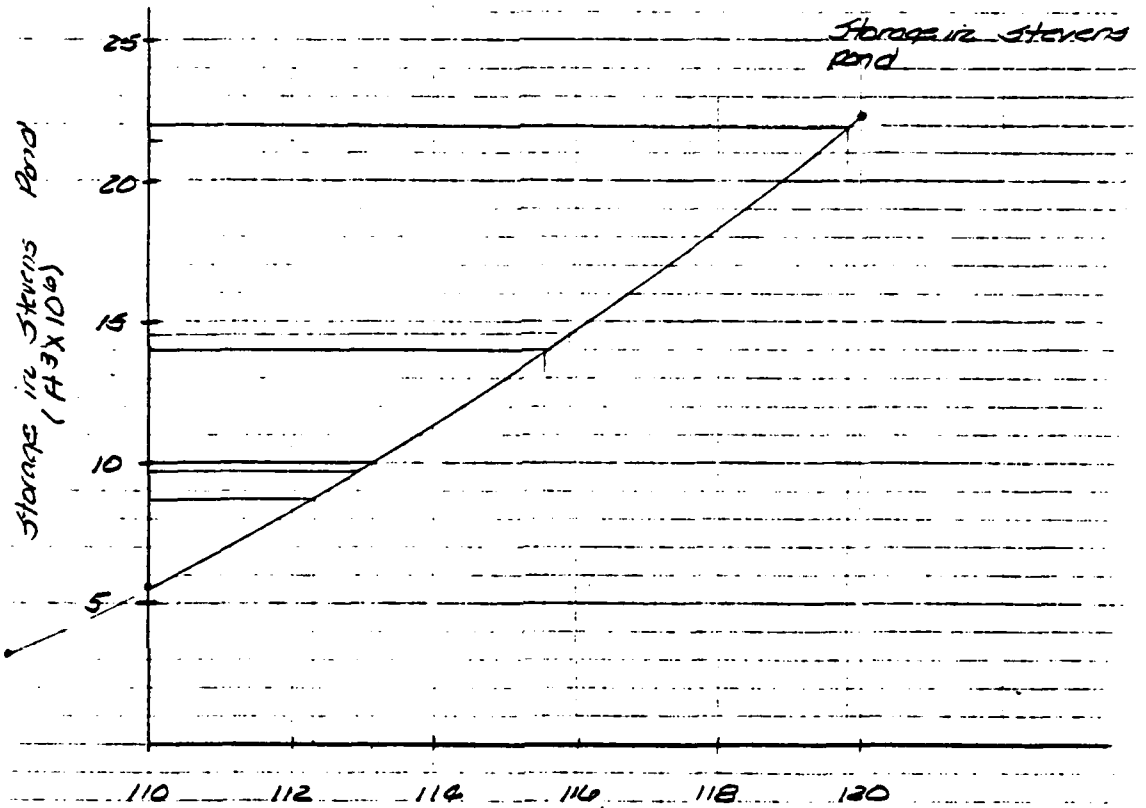
PAGE 20
DATE 11/12/82
COMPUTED BY dlad



Time (hrs)	Cumulated Inflow (Ft³)	Avg. Inflow (Ft³)	Water Surface Elevation
			s = 8,000000 Ft²
0	0		112.3
1	1,440,000	450,000	112.85
2	5,832,000		115.55
3	13,230,000		119.0
4	23,406,120		
5	32,514,120		
6	40,435,920		
7	46,143,700		
8	51,539,320		

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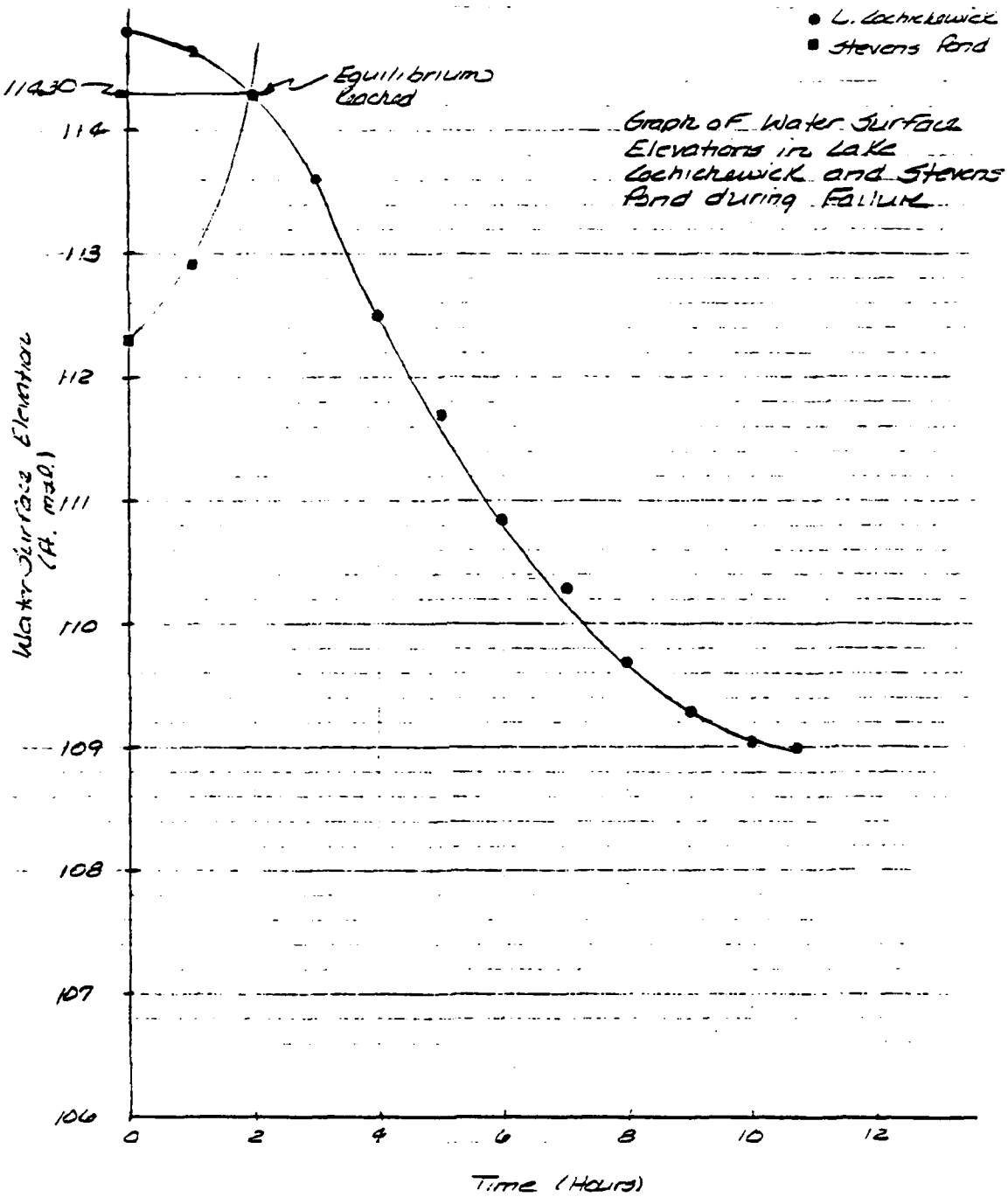
Boston Mass.

CLIENT Holyoke Hydro JOB NO 5612.01 PAGE 21
PROJECT Lower Lake Lachichewick CHECKED [illegible] DATE [illegible]
DETAIL Lake Lachichewick CHECKED BY [illegible] COMPUTED BY [illegible]



APPENDIX E
INFORMATION AS CONTAINED IN THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

(1) STATE	(2) IDENTITY NUMBER	(3) DIVISION	(4) STATE	(5) COUNTY	(6) CONGR DIST.	(7) STATE	(8) COUNTY	(9) CONGR DIST.	(10) NAME	(11) LATITUDE (NORTH)	(12) LONGITUDE (WEST)	(13) REPORT DATE DAY | MO | YR
MA	27M	NED	MA	009	06				LAKE COCHICHEWICK OUTLET DAM	4241.3	7106.3	08DEC78

(15) POPULAR NAME	(16) NAME OF IMPOUNDMENT
THE HATCH	LAKE COCHICHEWICK

(17) REGION	(18) BASIN	(19) RIVER OR STREAM	(20) NEAREST DOWNSTREAM CITY–TOWN–VILLAGE	(21) DIST FROM DAM (MI.)	(22) POPULATION
01	05	CONDUIT TO STEVENS POND	NORTH ANDOVER	0	15864

(23) TYPE OF DAM	(24) YEAR COMPLETED	(25) PURPOSES	(26) STRUCTURAL HEIGHT (FT.)	(27) HYDRAULIC HEIGHT (FT.)	(28) IMPOUNDING CAPACITIES MAXIMUM (ACRE-FT.)	NORMAL (ACRE-FT.)	DIST	OWN	FED R	PRV/FED	SCS A	VER/DATE
GRAVITY	1837	S	12	12	2380	1307	NED	N	N	N	N	15JAN79

(28) REMARKS
21-GATE STRUCTURE ONLY

(29) D/S HAS	(30) SPILLWAY CREST LENGTH	(31) TYPE	(32) WIDTH (FT.)	(33) MAXIMUM DISCHARGE (FT.)	(34) VOLUME OF DAM (CY)	(35) POWER CAPACITY INSTALLED (MW)	PROPOSED (MW)	(37) NAVIGATION LOCKS NO	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)
1	600		5	200												

(38) OWNER	(39) ENGINEERING BY	(40) CONSTRUCTION BY
TOWN OF NORTH ANDOVER		

(41) REGULATORY AGENCY DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MA DPW

(42) INSPECTION BY	(43) INSPECTION DATE DAY | MO | YR	(44) AUTHORITY FOR INSPECTION
HALEY + ALDRICH, INC.	030CT78	PUBLIC LAW 92-367

(45) REMARKS
30-CREST IS NATURAL SHORELINE 31-32-33-ONLY SPILLWAY IS OUTLET GATE

END

FILMED

7-85

DTIC